UNIVERSITY OF BIRMINGHAM

SMART MODEL ASSESSMENT RESILIENT TOOL (SMART): A TOOL FOR ASSESSING TRULY SMART CITIES

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A thesis submitted to
the University of Birmingham
for the degree of
DOCTOR OF PHILOSOPHY

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November 2018

Abstract

The smart cities discourse is a contemporary expression of urban matters, covering a wide area of scientific approaches. A general perception in smartness focuses on the technological developments that refer to city management and operations, often supported by corporations that act as service providers to cities and to individuals, as customers. This thesis, which views smartness through the liveability lens, re-examines the role of the smart city, providing evidence to assess the processes adopted in becoming smart. This thesis argues that current terminologies for 'smart' do not clearly define what 'smart' needs to contain if cities are to become more sustainable, resilient and liveable; that is, if 'smart' is to realise its full value. Notably the smart cities literature reveals that smartness can be perceived differently by different stakeholders, and sometimes with a strong focus on the economic pillar of sustainability. For this reason, it is argued that liveability should be a central feature of smartness if smartness is to realise its full potential in providing benefits to the population of a smart city. The term 'truly smart' is used herein to include considerations of people and the planet alongside economic and system efficiency and effectiveness. Consequently, it is argued that cities should adopt initiatives according to what is truly smart, that is assessed according to their liveability value.

This thesis describes the development of the Smart Model Assessment Resilient Tool (SMART) to assess whether cities are taking actions (i.e. adopting initiatives) that will move them towards 'true smartness'. It was found that CityLIFE, developed within the multidisciplinary EPSRC-funded research project 'Liveable Cities', is the most appropriate tool for an assessment of liveability in cities and this is accordingly included as part of the SMART to assess the liveability potential of the smart city initiatives. SMART is trialled in four case studies (Birmingham, London, Copenhagen, and Singapore) and, in the case of the two UK cities (Birmingham and London), the results are compared against qualitative

research involving local smart city experts to understand better their local needs and priorities. This process included in a SMART analysis can be deployed via group discussions to support decision making in cities, and more generally enable city decision-makers to assess current smart cities policies and initiatives and prioritise proposed initiatives. This will help to ensure that cities become more liveable, enhancing city living for the individual and supporting planetary well-being in cities now and in the future.

Acknowledgements

I would like to thank the Engineering and Physical Sciences Research Council (EPSRC) for the funding of the Liveable Cities project, Grant: EP/J017698/1, where this research has been part of (Principal Investigator: Professor Chris Rogers). I would like to express my sincere gratitude to my main supervisor and mentor, Professor Chris Rogers, for the continuous support of my PhD study and related research, his interdisciplinary approach and mostly his vision. Also, I would like to thank my supervisors, Professor Miles Tight and Dr Dexter Hunt, for their insightful comments.

Used Acronyms

AHP	Analytical Hierarchy Process
ANP	Analytical Network Process
ASCIMER	Assessing Smart City Initiatives for the Mediterranean Region
BCC	Birmingham City Council
BDF	Birmingham Data Factory
BSI	Business, Innovation and Skills
CAM	City Analysis Methodology
CBA	Cost Benefit Analysis
CCC	Copenhagen's City Council
CDO	Chief Digital Officer
CEA	Cost Effective Analysis
CIP	Competitiveness and Innovation programme
CityLIFE	City Liveability Indicator Framework Evaluation
Climate KIC	Climate Knowledge Innovation Community
DB	Digital Birmingham
DRSA	Dominance Rough Set Approach
EDF	European Development Fund
EIB	European Investment Bank
EIP-SCC	European Innovation Partnership on Smart Cities and Communities
EPSRC	Engineering and Physical Sciences Research Council
ESD	European Service Delivery
EU	European Union
FFC	Future Cities Catapult
GCC	Green City Commission
GDP	Gross Domestic Product
GLA	Greater London Authority
H2020	Horizon 2020
HS2	High Speed 2
ICT	Information Communication Technology
iDA	Info-communications Development Authority
IDC	International Data Corporation
IMDA	Inforcomm Media Development Authority
ISO	International Standardisation Organisation
ITU	International Telecommunication Union
KPIs	Key Performance Indicators
LA	Local Authority
LFEPA	London Fire and Emergency Planning Authority
LLDC	London Legacy Development Corporation
LTAS	Land Transport Authority Singapore
MCA	Multi-Criteria Analysis
MoL	Mayor of London
MOPAC	Mayor's Office collaborates with Policing and Crime
NM	North Mediterranean
NRF	National Research Foundation
NU	New Urbanism
NYCS	National Youth Council Singapore
OLC	Outer London Commission
OPDC	Old Oak and Park Royal Development Corporation
PAM	Project Assessment Matrix
PAS	Publicly Available Specifications
RC(UK)	Research Council (United Kingdom)
RIE	Research, Innovation and Enterprise

S1	Strand one
S2	Strand two
SCC	Smart City Commission
SCNM	Smart City Network Model
SCR	Smart City Roadmap
SCRAN	Smart Cities Regional Academic Network
SEM	South East Mediterranean
SLP	Smart London Plan
SMART	Smart Model Assessment Resilient Tool
SMART	Singapore-MIT Alliance for Research and Technology
SME	Small Medium Enterprise
SNS	Smart Nation Singapore
SPeAR®	Sustainable Project Appraisal Routine
TfL	Transport for London
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
WRC	World Cities Report

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CHAPTER 1: INTRODUCTION

1.1 Background

Human settlements have always been identified by a cluster of habitable, protected spaces primarily for labour and residential purposes. Organised living introduced a new administrative role, for example in Ancient Athens, an autonomous city-state (polis) that supported the organisation of agricultural areas, which later expanded to parts of Asia Minor (Dynneson, 2008). During the Golden age of Pericles, the polis of Athens, which became the first self-governed region, conceived the meaning of the innovative administration of democracy (Bolis, 2015):

> *'ὄνομα μὲν διὰ τὸ μὴἐς ὀλίγους ἀλλ' ἐςπλείονας οἰκεῖν δημοκρατία κέκληται·' Thucydides*
>
> *'it is true that our government is called a democracy, because its administration is in the hands, not of the few, but of the many' (p 30-32,HPFPD, 2005; trsl.. Jones and Powell, 1942).*

The meaning of which was that the word democracy refers not to the minority, but to the majority of people in the city. Yet this idea constitutes not just the ability to act on the verdict of a vote, but on the inhabitants' right to participate and operate within the city (Ober, 2008). This concept resulted in Athenian achievements in sciences and the arts (Prichard, 2010). In the late medieval times, the merchants' operations in the guild, a term used to describe a group of merchants with social power, led to innovations that shaped the city financially and culturally far more profoundly than any economic activity that took place in agricultural areas – in essence, merchants' social relations influenced local decision-making (Davids and Munck, 2016).

This thesis explores the whole idea of a smart city: the effect of smartness on cities and people, and decision-making processes, and the relationship between them. Furthermore, it explores the effect of the smartness on urban living (Colding, 2017), a concept that embraces both individual and societal wellbeing, and planetary wellbeing (Liveable Cities, 2013). Additionally, the thesis acknowledges that the types of solutions offered through technology respond to certain types of city challenges, but have impacts, both positive and negative, and these are often not explored. Here, the success of technological innovations in achieving the holistic betterment of city living is explored, so that such

innovations might resolve challenges rather than creating more challenges. Therefore, the question of how a city can realise its ambition of being 'smart' is explored in this thesis. To support this effort of understanding what 'smart cities' means, the next section describes the context of cities, in historical terms, and the uncertainties in the smart movement.

1.2 Context and Scope

Over time people have been attracted to the promise, lure and opportunity of a better way of life within the city, one in which vibrant spaces and (increasingly smarter) infrastructure responds to the changing needs of the population. 'Smart' has been a buzzword used by cities and citizens for more than a decade now. A smart city is a subject that contains many uncertainties and before this thesis embarks on the exploration of what makes cities smart, we must take stock of what historically we mean when we refer to a city (Cavada *et al.,* 2014). Often, smart is used to refer to a product or products that are seamlessly connected to the internet and claim to make our everyday life easier, more efficient and enjoyable. However, not all smart cities relate to this technically-oriented ideology, because a city is more like a liveable organism, where people have different approaches to how they (choose to) live.

Not far back in history, the concept that '*the house is a machine for living in*' (Corbusier, 1931 pg. 107) can be developed to give a projection of how a modern city functions and provide for increasing populations. Today, according to the United Nations (UN) urbanisation report (UN, 2015), city populations (3.42 billion) exceed those in agricultural areas (3.41 billion), which might be noteworthy in terms of the global population, yet immensely significant in terms of spatial distribution. The discrepancy of intense concentrations in urban areas (in some cases too intense, resulting in claims of overpopulation in those particular contexts) is a product of the economic activities taking place in cities having created social imbalances (Sassen, 2009).

Moreover, the contexts in which cities in general, or terms relating to smartness more specifically, operate are subject to change. For example, cities today are vulnerable (and also contribute) to climate change and so are exposed to potentially hazardous risks (Satterthwaite *et al*., 2007), smartness could therefore include some attempts to ameliorate these effects. Contemporary city trends within the

developing world, thinking of cities such as Dubai and Shanghai, find cities growing at a remarkably fast pace in both spatial and economic terms, exacerbating environmental and social challenges, whereas some post-industrial cities, such as Detroit and Pittsburgh, are experiencing a considerable population decline, bringing very different environmental and social challenges (Beauregard, 2009). In response to these city challenges, efforts have been made to understand them by reflecting them in an umbrella of city idioms, each referring to a range of issues (Joss *et al*., 2015). One such idiom is the phenomenon of smart cities, suggesting that cities that are named 'smart' can achieve an enhancement in quality of life (Exner, 2014), the problem here being interpretation of the term 'quality of life'. Ever-increasing connections between technological developments in urban systems and their operation are often claimed to be at the core idea of a city becoming smart (Nam, 2011), as many subscribe to the idea that technology is the way for cities to become smart (Dohler *et al*., 2011).

Therefore, cities have been a mixture of opportunities and they often, but not always, work effectively as independent urban spaces; the phenomenon of the metropolis has empowered cities to become economically independent, environmentally aware and more socially inclusive. Interestingly a metropolis is a place that has been through rapid development over recent decades, where previously unimagined infrastructure (not least communications) and ever-more complex buildings appear almost overnight. In addition they attract ever-increasing numbers of people from other countries and very rapidly become international epicentres of talent. This brings with it the opportunity to create a booming economy and rich billionaires, yet also creates difficult living conditions and inequality. Hopefully, new types of cities are starting to evolve that focus on better living standards (offered in their own contexts) for all. Evidently, city rankings now recognise this and include ratings for 'best life quality'; it is, however, unclear how this translates to everyday life. Consequently, many cities promote different visions for living and as such this had led to a wide and diverse typology of cities.

A smart city according to this research is an overarching concept of these various different typologies (Rogers, 2018). A smart city does not entirely operate using digital technologies since this would mean that those who cannot afford to buy, or update, their technologies, or even be willing to

engage with them or be trained to use them in the first place, are instantly excluded from the smart concept. However, at the same time, it is undoubtedly difficult to frame exactly what 'smart' is and what it is not – this is influenced in many ways by a city's local context and local conditions. For this reason, this thesis gives a general introduction to the subject of smart cities. It explores the whole idea of 'smart', where smartness is a contested term, and different people interpret it differently according to various opinions. In order to address issues of smartness, it is essential to understand the different interpretations of being smart. Although 'smart' is often perceived to be related to technology, this research perceives the issue of smart not explicitly through technological advancements (Hamblen, 2015). On the contrary, in some cases, technology can create disparities between users and non-users and it would be problematic to describe this situation as 'smart'.

The focus of this research is to explore urban living through the lens of people living and operating in a city and in harmony with the natural environment. Specifically, a case study of Birmingham, UK, is included, in part to respond to the City Council's vision for 2026 of a better quality of life in Birmingham (BCC, 2008) and its ambitions to become a smart city and an exemplar for other cities. The focus of this research therefore, supports the idea that people are the main focus of cities, are connected to their city systems, and aspire towards better living both today and in the future. Given the wide variety of interpretations of the term 'smart', in this research the term 'truly smart' is used to mean, in addition to movement towards more efficient and effective city systems and citizens (a state that in this thesis is defined as 'smart'), enabling cities and citizen to move towards a more sustainable, resilient and liveable state. [Liveability in this context is interpreted as meaning individual and societal wellbeing and planetary wellbeing, for which sustainability and resilience are essential features, as discussed immediately below.] To facilitate judgements on this advancement, the research seeks to create a transparent, accessible and resilient model that can be used to understand how smart cities are and how they can become 'truly smart'.

This 'Smart Cities' doctoral research is part of a wider research programme entitled 'Liveable Cities: Transforming the Engineering of Cities to Deliver Societal and Planetary Wellbeing' (Liveable Cities, 2013). Similar to the interpretation of 'smart', the term 'liveability' is also contested: different

people are interested in liveability in different ways. In this thesis, liveability is explicitly analysed in relation to the fundamentals of city engineering needed for the betterment of living in urban areas, now and in the future, by adopting the definition of "individual and societal wellbeing and planetary well-being" in which sustainability and resilience are necessarily core features (Liveable Cities, 2013). Members of the programme consortium, across disciplines including engineering, economics, architecture, geography and social science from four UK Universities, have created and used interdisciplinary methodologies. Those engaged in shaping the smart cities idiom are exploring and developing a concept that is incrementally gaining a reputation for positively influencing future living operations. For this reason, this thesis safeguards the term from being strictly technically-related, and opens it up to the idea of embracing liveability, as this provides overarching benefits (i.e. benefits beyond efficiency and effectiveness of current systems operation) and therefore makes it a relevant topic of study as part of 'Liveable Cities'. In the following section 'truly smart' is referred to the true goal of smartness.

Dealing with the existing and proposed terminology in thesis is an additional challenge that has been clarified in terms of the three core definitions in this chapter and is studied further in Chapter 2. Specifically, discussing terms such as 'smart' 'truly smart' and 'liveability' underlines the necessity of clarifying the concepts involved in the smart cities discourse since they inevitably overlap with each other. However, this research has made the distinction between what is currently is meant by smart – a general term related to improvements in cities and city systems, characterised by various stakeholders' views (Cavada *et al.,* 2014) and what should be included in cities' policies and actions if they are to advance to a better state – a 'truly smart' state that combines city system efficiency and effectiveness with enhancement of sustainability, resilience and liveability. True smartness therefore provides the dominant point of reference, as embraced in the hypothesis underpinning this research.

1.3 Hypothesis, Aim and Objectives

1.3.1 Hypothesis

The hypothesis of this research is:

Smart cities are only 'truly smart' if they are moving towards enhanced liveability – they deliver acceptably good individual and societal wellbeing and planetary wellbeing, and embrace public participation in support of this delivery.

To assist in this task, the research also addresses the following questions:

- What do we mean by smart cities?
- Smart to whom?
- What do people think about smart city initiatives and how have they interacted with initiatives that have been adopted to make cities smart?

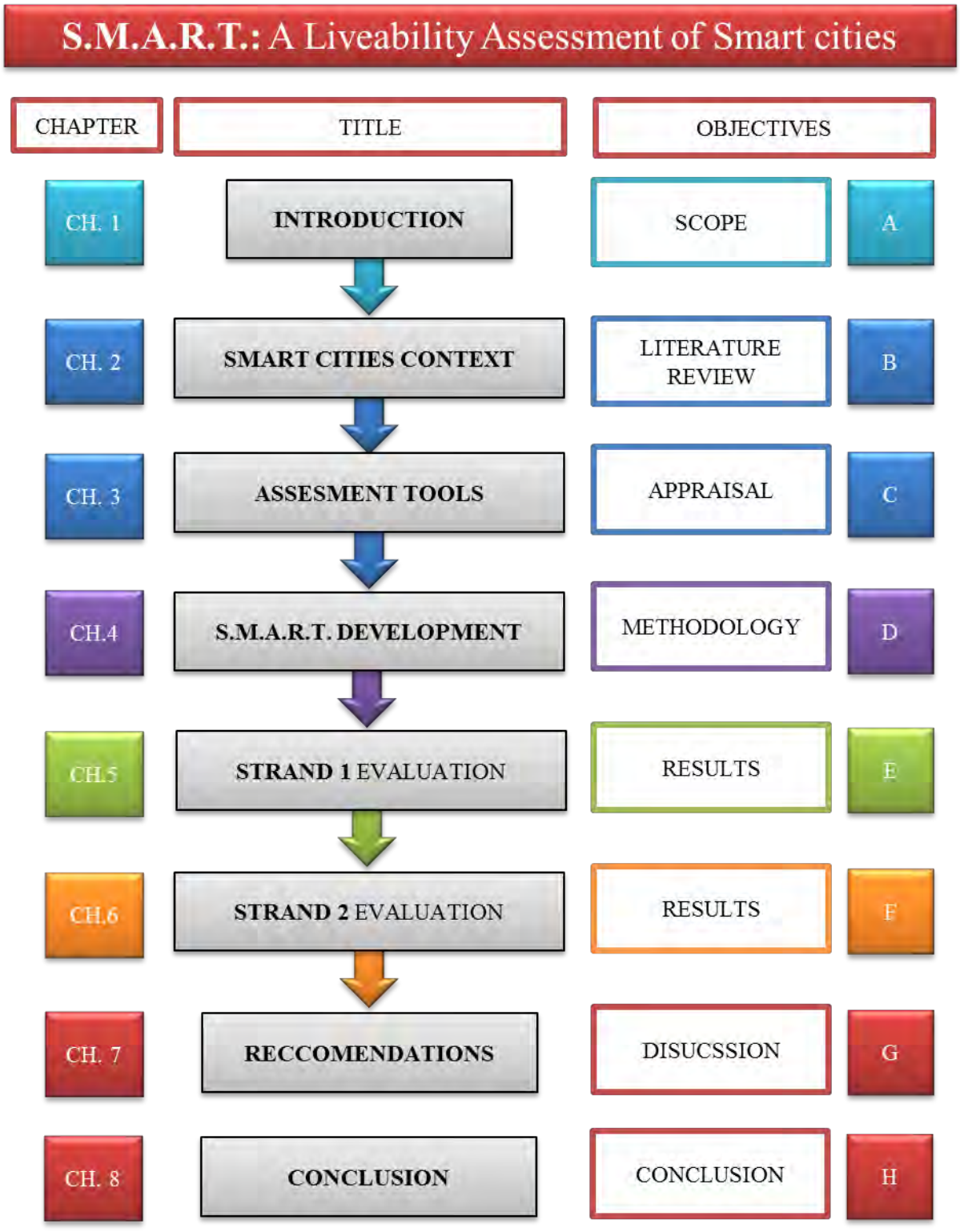

Figure 1.1 Overview of the Smart Cities Research Programme

1.2.2 Aim

The aim of this research is to test the hypothesis by developing a methodology to identify and analyse smart city initiatives and trial it in case study cities to establish the degree to which they enable these cities to become 'truly smart'; i.e., to become 'liveable' according to the definition adopted in this thesis.

1.2.3 Objectives

The following objectives were conceived, and refined as the findings emerged, to meet the aim.

Objective A: To test the hypothesis by critically reviewing the literature to explore whether, and to what extent, smart initiatives explicitly focus on the achievement of 'true smartness' and embrace public participation.

Objective B: To undertake a critical analysis of the literature on smart cities.

Objective C: To identify existing tools for assessing smart cities, determine if they are suitable for assessing whether cities are truly smart, and, if no a suitable tool exists, identify what would be needed in a new tool.

Objective D: To develop a methodology, based on the City Assessment Methodology (CAM) developed in the Liveable Cities programme (Leach *et al.*, 2016), as the basis of a suitable tool to assess truly smart cities: the SMART.

Objective E: To test the hypothesis by identifying and assessing, using the SMART tool (Strand One, S1), the initiatives that four cities – two UK cities and two international cities as the exemplars of smartness – have used to become smart.

Objective F: To test the hypothesis using the SMART tool (Strand Two, S2) for two UK cities, Birmingham and London, which takes into consideration local experts' opinions.

Objective G: To make recommendations on how cities could become truly smart (i.e. liveable) according to the outcomes of objectives E+F (S1+S2).

Objective H: To draw conclusions on the extent to which the hypothesis has been proven and whether there is a need for future research, and if so, what more should be done in that respect.

An overview of the research programme and its reporting is shown in Figure 1.1.

1.3 Structure of Thesis

This section provides a brief description of each chapter in this thesis.

Chapter 1: Introduction to the context of this research, setting the hypothesis, aims and objectives and providing an overview of the thesis.

Chapter 2: The literature review explores how cities have approached the issue of smartness via city initiatives. It highlights the difficulty of capturing the meaning of liveability in smart cities because of the diversity in meaning and presents the gap in knowledge regarding the meaning of liveable for smart cities by reviewing smart city examples and assessment tools.

Chapter 3: A critical appraisal of assessment tools, as part of the literature review, to identify which is most suitable to form the basis of assessment of truly smart cities.

Chapter 4: Having identified the challenge of analysing smartness in terms of individual, societal and planetary wellbeing, Chapter 4 describes a methodology for addressing this challenge. It describes the development of a framework – SMART (Smart Model Assessment Resilient Tool), which uses the CityLIFE tool (Leach *et al.*, 2017 a, b, c) to establish how well the actions were taken by a city deliver truly smart outcomes.

Chapter 5: SMART Strand One (S1) is used to evaluate four case studies – Birmingham, London, Singapore, and Copenhagen – to assess their smartness in terms of liveability. The evaluation uses local smart initiatives to test the hypothesis.

Chapter 6: SMART Strand Two (S2) is used to evaluate two UK case studies (Birmingham and London), taking into consideration local experts' opinions in the assessment.

Chapter 7: Presents a discussion of the application of SMART and the results from the case studies in the light of current knowledge; arising from this discussion, recommendations are made for how the findings from the research can be applied to any city in practice.

Chapter 8: Conclusions of the research and recommendations for further research to build on its findings.

CHAPTER 2: A LITERATURE REVIEW ON SMART CITIES — MEANING AND EXEMPLARS

2.1 Introduction

Chapter 2 is a critical review of literature in support of, or countering, the hypothesis. Following on from the discussion in Chapter 1, where smart is described as a contested term formed by the views of those professions that use the term, a major issue in exploring the idea of smart when reviewing the literature is deciding upon an appropriate focus. For this reason in this thesis, smartness is explored in the current literature in terms of liveability – individual and societal wellbeing and planetary wellbeing – as defined in the 'Liveable Cities' project. Cities, for the purpose of this thesis, are described as having agency – they are considered to be living and evolving systems of systems that can influence their liveability and the language in the thesis reflects this viewpoint (Joss, 2013). The limitations of adopting this viewpoint will be made clear at relevant points in the discussion of the research and its findings. This literature review first investigates current city themes, as smart is one of them; secondly, it explores what it means to be a smart city; thirdly, it explores the hypothesis through current exemplars of smart cities; and fourthly, it establishes how smart cities have been assessed so far. This is extremely important when one considers that there are multiple expressions for smartness globally. Even the UK's attempts to develop a clear definition and set of standards for smart cities (i.e. PAS 180 and PAS 182) appear to suffer from fundamental differences in how the semantic content of a 'smart' city is organized and defined (BSI 2014 a, b; 2015). As such, smart cities currently lack a robust, coherent shared definition, with many contradicting facets that underline the necessity to develop a liveable smart vision (Cavada *et al*., 2014).

Currently, in spite of many world-class exemplars, there still appears to be a disconnection between overall interpretations of what 'smart' actually means, hence it is not surprising those smart cities are not taking off at the rate one might have expected and are not truly realizing the projected potentials (Dohler *et al*., 2011). For example, in 2005, the Clinton Foundation, in the USA, challenged network equipment maker Cisco to use its technical know-how to make cities more sustainable,

potentially a step towards liveable smart cities (Swabey, 2012). Since that time, Cisco has become involved in constructing such cities; for example, Songdo in South Korea, developed with consulting engineer Ove Arup and Partners. Songdo is built around the idea of encouraging and fostering sustainable design practices through the incorporation of the latest technologies to: reduce energy consumption; increase energy efficiency; generate clean and renewable electricity; and utilise recycled and natural materials (Songdo, 2014). Similarly, PlanIT Valley in Portugal, developed by Siemens and consulting engineer Buro Happold, sought to combine intelligent buildings with transport and receive information on mobility, energy, parking and emergency services (Living Plan ITSA, 2013). IBM has contributed significantly to the provisioning of technology, in particular in advancing the smart city debate rather than the liveability agenda (Falconer, 2012).

This chapter explores the frustration involved in achieving liveable smart cities and deals with the uncertainty surrounding the term by proposing a set of steps as the methodological process for the literature review, which is outlined in Figure 2.1.

STEP 1: considers 'City Themes' that emerge from the literature (Section 2.2)

STEP 2: discusses the meaning of the 'Smart Cities theme' (Section 2.3)

STEP 3: explores existing 'Smart City exemplars' (Section 2.4)

STEP 4: The fourth step explores existing 'Smart City assessment tools' (Chapter 3).

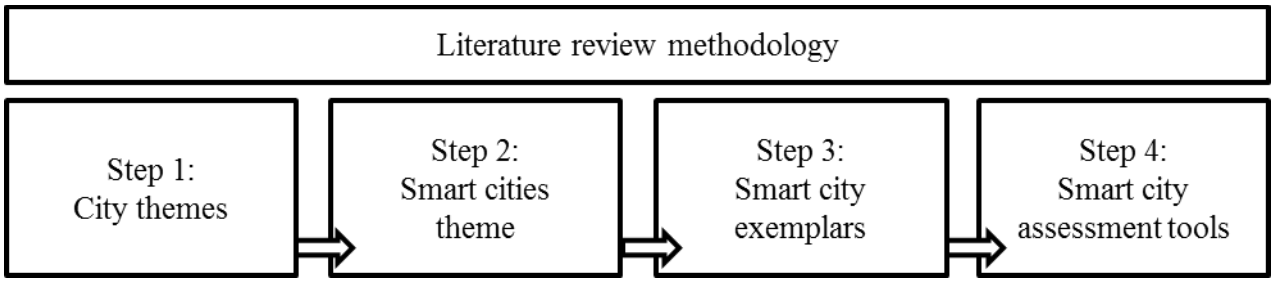

Figure 2.1: Methodology for the literature review

2.2 City Themes (Step 1)

This step explores cities as a contemporary concept in order to describe the various ways in which they are interpreted and conceived. By undertaking this step, one can explore the nuclear meaning of the term 'city' as being locales of progress across both time and space (Dodgson and Gann, 2011).

Although it is impossible to provide a single explanation of what constitutes a city, Hollis (2013) portrays a city as a circumstantial place marked by its resources (also present in the Liveable Cities project) and one that spatially expands over time. Yet a contemporary city is far more than this – a vigorous, ever-changing (open-ended) system of systems with their own connections and differentiations. It is, however, justified that large-scale urban areas are beneficial to people and the economy, often as a product of an exceptional organisation of their resources (Batty, 2012). Cities contain within them a huge diversity of opportunities, but also create many challenges, such as pollution and waste, and often an inability to address environmental challenges (Parkes, 1973). Hollis (2013) understands the city to be a holistic and complex living being, based on its connections working and developing independently, generating advancements, as well as obstacles, that can have extreme consequences for the environment, humanity and, generally, for the liveability of a city.

Very recently, digital technology has been able to capture and process particular attitudes that the majority of people and communities articulate – in essence their different values and needs (Bifulco *et al*., 2015). A city becomes a platform of digital production with matured sectors of the public realm (Harrison *et al*., 2010). According to the World Cities Report (WCR, 2016), however, new technologies can exacerbate urban divisions rather than offering people equal opportunities to solve urban challenges. Given this, it is evident that a systematic approach that reflects social situations is needed if it is to provide for emerging city themes or, as Greenfield (2013) puts it; the granularity of cities shapes a democracy able to communicate the aspirations of their parts. Although urban development is considered to be a result of industrial development, an investigation of the thematic strategy of cities, along with stakeholders' participation, presents a more comprehensive approach to understanding the challenges that cities face today (Mosannenzadeh and Vettorato, 2016; Rasoolimanesh *et al*., 2016). For this reason, the literature review is conducted by starting with city themes, and by doing so, it supports the idea of smart enabling decision making regarding the thematic challenges in cities (WCR, 2016). However, as the Liveable Cities programme has demonstrated, any tendency for cities, or the outcomes of any interventions in cities, to deliver smartness (termed herein 'initiatives') to be ultimately considered in silos is counterproductive – cities

should be considered to be complex systems of systems, and an intervention in any one system has the potential to impact on all other city systems to a greater or lesser degree (Rogers, 2018).

2.2.1 Thematic Approaches

In this step, the key city themes considered broadly embrace many of the current city themes, specifically as described by the Future Cities Catapult discussing future cities (Moir *et al*., 2014). An approach for cities emerged as the New Urbanism (NU): to use cities not as the problem of contemporary living, but as the way to provide solutions to challenges (Davies and Townsend, 2015). In the USA, for example, New York has published the 'greater' city aspirations of a green future, aiming to develop spatially (residential and green areas) while taking cognisance of environmental considerations (brownfields, waterways, water supply, transportation, energy, air quality, solid waste and climate change) (City of NY, 2011). While this might seem too specifically focused, it is used as a vehicle for far wider social and environmental transformation, which lies at the heart of liveability as defined in this thesis. Initially focussed on the UK context, this research follows recommended principles promoting citizen empowerment, leadership, city finance, and sustainable development to lead the future city vision and ensure the efficacy of current and prospective city visioning into the city agenda (Rogers *et al.*, 2014a; Rogers, 2017). The Future Cities Catapult (FCC), an organisation working under the umbrella of Innovate UK, published a report on "*Future Cities*" in terms of a systematic approach of future city visioning (Moir *et al*., 2014). In this report, they consolidate the themes into four main categories (Environmental, Social, Economic, and Governance), each referring to a number of city themes as 'ideas' that carry different meanings to different groups (Moir *et al*., 2014). Each theme (the themes are presented in Table 2.1) is explored using descriptions found in the literature and, when combined, they provide an umbrella for the analysis of the smart city. By highlighting these suggested themes, we can understand the landscape of themes within which cities around the world operate – tailored to both contextual needs and current and future city challenges.

A discussion of the four categories in terms of the city themes that they embrace is presented below: Environmental (Section 2.2.1.1), Social (Section 2.2.1.2), Economic (Section 2.2.1.3) and Governance (Section 2.2.1.4).

Table 2.1: Thematic approaches to cities (FCC, 2014)

Environmental	**Social**	**Economic**	**Governance**
Garden	Participative	Entrepreneurial	Managed
Sustainable	Walkable	Competitive	Intelligent
Eco	Integrated	Productive	Productive
Green	Inclusive	Innovative	Efficient
Compact	Just	Business friendly	Well run and led
Smart	Open	Global	**Smart**
Resilient	**Liveable**	Resilient	Future

2.2.1.1 Environmental

The themes of the environmental category require a multi-disciplinary and group action approach due to the complex level of understanding required to effectively inform and frame a specific policy (Harrison *et al*., 2010). The challenges, or indeed solutions, in this category are typically structured around climate change and the impact this has on the environment (such as air quality), both in terms of perception and spatial design. A garden city is a low density and radial-axis planned urban space, characterised by walkable paths and green areas, initially aiming to provide space for social connections, but which later led to more segregation and suburban development (Sharifi, 2015; Southwort, 2015). A wider approach in the environmental theme, sustainable cities, considers a direction for city growth focussed on ecology, liveability and a flourishing economy. Also fundamental in this wider approach is a 'sharing' view of cities that adds to sustainability and presents future opportunities (Neuman and Churchill, 2015; McLaren, D and Agyeman, 2015), whereas eco-cities can be considered as focussing a little more narrowly on one of the pillars of sustainable cities. Foremost when it comes to the thematic approach of sustainable cities, importance is often very much focused on climate change and its associated challenges, such as a low carbon-solutions agenda (Moir *et al*., 2014).

Green cities (similar to biophilic cities, see below) could and should be considered part of the environmental city; seeking to tackle environmental issues in an array of urban contexts, being part of the sustainability agenda (Batley and Newman, 2013). Specifically, biophilic cities attempt to link the very heart of nature to human pleasure and are described as the connection of the natural environment and humans, ensuring the greenness of cities is enhanced (Neuman and Churchill, 2015). Similar to

the garden city, a compact city considers the pace of city sprawl, socio-economic relations, movement, infrastructure and other practices in designing the spatial ecology in an organised development (Neuman and Churchill, 2015). Environmental thematic cities are discussed in the visioning of prospective themes, such as smart. Smart cities are considered to be an advanced level of sustainable cities, introducing a recently formed agenda of efficiency and participation, which can be considered one of the main opportunities for the development of smart ideas (Gabrys, 2014). Similarly, resilient themes also explore, in a predictive way, the capability and the level of vulnerability of the urban context (depending on the scale and rate of occurrence of any given disruption for future exposure to a range of expected and unexpected dangers) (Blackburn *et al*., 2012). The aim of resilient cities is primarily to retain their quality of life, economy and environment through resistance to external environmental and other changes (Moir *et al*., 2014; Soderlund and Newman, 2015), or an ability to adapt and respond (Rogers *et al*., 2012).

Some of the themes are broadly similar because they present answers to climatic urban challenges, and they have no distinct, realistic policy or effective urban planning design strategies (Rocco, 2015). Although marginal differences between the environmental themes are not so clearly identifiable—since they share climatic challenges and approaches, this 'thematic cities' category has liveability implications through its climatic (and sustainable) lens that could work together for the city environment and citizens' wellbeing.

2.2.1.2 Social

In the social category, themes describe practices that engage citizens with the city and each other. For example, in participative cities, efforts should primarily engender a self-explanatory city, where values are accessible, easy to understand, and affordable; also, where systems span across all scales of the urban realm (Kransky, 2014). Social cities can be supported by the walkable city theme, where urban space is provided for citizens in an urban design approach that delivers public safety, offers additional health implications and fosters social cohesion (Gehl, 2010, Tight, 2016). A similar spatial connection is feasible in integrated cities, to help restore inequalities generated within the urban environment (mainly due to employment disparity) and additional planning is required to address the

external connection of cities and rural areas (Picard and Zenou, 2018, and Yan *et al*., 2018). The types of these social connections depend on the social values of inclusive cities and their focus on efforts to enhance participation in the civic realm (Gerometta *et al*., 2005). Social cities not only focus on similarities but should accommodate differences and recognise diverse cultures to create a collective built environment able to be accessed by all (Afacan, 2011).

Although just cities is a generalised term, the social theme of cities is argued to provide a foundation for environmental and social equity, or justice, in cities and how this connection can become the basis for a positive future cities agenda (Cook and Swyngedouw, 2012). With the recent advances of digital information, open cities can expand further than their geographical boundaries and local elements expand to a wider scope of social opportunities (Porta, 1999). Therefore, liveable cities are manifested in this context, using new parameters (technology being one of them) to provide a new urban agenda, rather than solely the consideration of systems themselves, wherein management, efficiency and living conditions in the city aim to achieve the fulfilment of human prospects in city living and the raising of citizen expectations (Moir *et al*., 2014).

2.2.1.3 Economic

Currently, the economic element of cities refers both to small- and large-scale monetary systems among the city themes. When it comes to entrepreneurial cities, there is a level of difficulty in establishing exactly who the entrepreneur(s) is/are and, therefore, it is difficult to establish the precise form an entrepreneurial city could take. For example, if we perceive the city as the entrepreneur does, then the city promotes itself according to its local achievements in order to attract popular interest from other external sources (Dormans *et al*., 2002). Dubai is considered to have exceeded local expectations and, along the way, constructed a new urban realm, which has, in a very short period of time, skyrocketed Dubai from a desert location to an international metropolis. Nevertheless, Dubai's development has western influences, and its legacy is questionable in many respects; for example, its engineering solutions have been much criticised for a lack of attention to environmental destruction (Miller, 2011). Due to fiscal gains, competition between cities is the norm nowadays; competitive cities are using methods to assess and compare themselves, hence economic competitiveness is the

most common criterion advocated to recognise their suitability to address urban challenges – economically strong cities also appears to consider citizens' wellbeing (Lever and Turok, 1999; Malecki, 2007). These strong economic cities are often large urban metropolises that, as productive cities, attract human talent in international businesses or small-scale entrepreneurship, where human resource is highly competitive, and the financial return is higher (Behrens, 2014). This discussion implies that economically strong cities can afford to address the issues of wellbeing and that this, in turn, will help to attract the high-quality talent needed to maintain that economic strength. As a result of the '*knowledge economy*', innovation mostly develops in cities that are either characterised as cities that are the product of innovation or as an area that draws talent into their innovative environment (Marceau, 2008).

In contrast to Dubai's fast and enormous scale of urban development, small-scale and local developments are another way of translating the entrepreneurial city. Such small-scale entrepreneurship is explained with the Silicon Valley model, since economy is highly associated with regional growth, and specifically with growth due to large quantities of smaller businesses, as these have lower costs compared to large companies; an entrepreneurial ethos and a large quantity of highly educated people or 'smart people' are all key to its success (Chatterji *et al*., 2013). In such business-friendly cities, the recent entrepreneurship model is not a guarantee for driving business growth in cities, as it is focussed more on stylised urban living; however, it has led to a new business model based on sharing (such as bike sharing) and the development of partnerships between investors and the city governance (Shasheen *et al*., 2010). Furthermore, these large urban centres (global cities) allow connections between local and international corporations, mostly for investment purposes, that subsequently result in an influx of people, yet are characterised by increased complexity arising from uncertainty over economic and social integration (Goerzen *et al*., 2013). In economic terms, resilient cities as a theme explain the cycles observed in cities, i.e., cities that undergo the consequences of economic decline caused by the mismanagement of large organisations and then experience the development of local entrepreneurship (Simmie and Martin 2010).

2.2.1.4 Governance

Governance influences most of the previously discussed themes since it relates to the organisation of cities. The idea of managed cities is based on their potential to be self-managed, aiming to generate an even distribution of resources and stakeholders that can administer change more efficiently (e.g. the effects of climate change are specifically quoted in this context), although such agendas can also become subject to political dispute (Allen, 2003; Ward, 2006; Homeier, 2013; Jacobi & Peres, 2016). Technology has played a big role in self-organisation – since the 1990s, the predecessor theme of computer-generated themed cities has seemed to move away from human involvement and decision-making in favour of a more mechanically driven process and automated services (Moir *et al*., 2014). Following this automated form of governance, intelligent cities emerged as a supportive mechanism for these city systems that can advance the city using digital decision-making processes and tools (Nam and Pardo, 2011). In this way, cities become progressively automated; they can calculate human needs, control outcomes and establish a system that could expand, along with an array of intelligent technical advancements. Intelligent cities were initially seen as a composite system of the human sensory procedure, in which human knowledge is considered the basis of innovation and the 'intelligent' city network (Mitchell, 2006). Potentially, digital systems could better govern cities (creating well-run and well-led cities) and offer a more productive systems approach. Although, perhaps they would be less productive where there is poor coordination of infrastructures (Ahrend, 2017).

Therefore, in respect of governance, digitalisation offers efficient cities the ability to measure their contribution towards climate change that affects them (i.e. in terms of emissions), and therefore not take a role just as a reactor to change; this also provides the means to develop a standards system to efficiently tackle challenges on a local governance or national level (Hurd, 2012). Essentially, smart cities can be governed to become smart only if all the stakeholders of the society unite in a shared decision process to face the current and future complex challenges (Coe *et al*., 2001). The challenges are to incorporate all these themes into prospective opportunities in cities and work out how policy

can merge these into one framework and create realistic scenarios for peoples' wellbeing, creating a liveable future, as the main aspiration of future cities (Campbell, 1996).

2.2.2 Thematic Cities Conclusion

Thus far, it might be suggested that sustainable, liveable, entrepreneurial and intelligent cities are some of the key city themes that reflect the challenges and opportunities faced within urban contexts today, and this helps frame future(s) thinking in this respect. Almost all of the thematic cities explored here aim for the betterment of living quality in cities, as sustainable, green, compact and resilient themes have shown. Additionally, the new technological elements could help cities achieve these goals and, in so doing, become more entrepreneurial. However, the high-level conclusion is that these thematic cities offer a new view of what cities are and what they should achieve as their vision, through specific goals that derive from the themes. Whether tackling environmental challenges, delivering protection against future uncertainties or taking advantage of technological opportunities, cities, probably for the first time, have recognised themselves as active urban entities and not simply entities that are the result of their contextual circumstances. The next section recognises that smart cities, as a new city theme, should be studied in detail and, through a critical analysis of various literature, a deeper understanding of what constitutes smart cities should be sought.

2.3 Smart Cities Meaning (Step 2)

Within the context of thematic cities, smart is typically categorised within environment and governance themes, and is therefore specifically categorised above, however, there is no clear justification as to why it only appears in these two themes, or what the clear essence of smart is (Cavada *et al*., 2014; Moir *et al.*, 2014; Neirotti *et. al.*, 2014). An analysis has been done, published by Cavada *et al.* (2014), in terms of a matrix of smart city definitions, exploring their stakeholders and thematic approaches. Similar stakeholder categorisation is followed in this thesis, in an attempt to produce a coherent understanding of the smart cities discourse, embracing liveability and participation. For this reason, this thesis uses 'academic', 'commercial' and 'governance' categorisations to discuss the meaning of smart in the sections below. The purpose of reviewing the

meaning assigned to each category is to explore each category's agenda and provide evidence to support, or counter, the hypothesis.

2.3.1 Academic

Smart is a growing sphere in academic research, however, academics are often critical of the term 'smart' and the way it has developed in various areas. The main categories are outlined in the sub-sections below in order to explore several critiques within academic discussions of smart cities that define this group. This is in comparison with the commercial and governance stakeholders' group explored in Sections 2.3.2 and 2.3.3.

2.3.1.1 Technology –Information Communication Technology (ICT)

The concept of smartness has developed from a state in which it was non-defined to one which has emerged mainly with the ever-increasing connection of technological developments in urban matters as the core idea of a city becoming smart. More specifically, this refers to turning data gathering, tailored to citizens' needs as a way to enhance inclusivity and personalise decision-making with the use of Information Communication Technology (ICT), into an urban task of furthering urban understanding and, ultimately, managing spatial information (Schaffers *et al.*, 2012; Murgante and Borruso, 2013). As technological advances cannot suggest liveability solutions on their own, digital technology should be considered as a means to positively influence the operations of a city alongside the adoption of existing concepts in order to understand how to advance life quality (Goodspeed, 2015). This would be a complex response to urban challenges: using ICT for systematic thinking that leads to technological innovations (Nam 2011; Söderström *et al*., 2014). Academic discussions on smart cities are becoming more particular on how technological innovation can use individuals' communication, and make use of their data, as the main advancement of smart-themed cities (Allwinkle and Cruickshank, 2011). Data as a tool could lead to a better quality of life, as it entails solutions that are facilitated by providing a digital platform in order to optimise the city's societal and environmental resources and facilitate interconnections that respond to many of the economic issues that potentially lead towards economic decline (Hollands, 2008, Kehoe *et al.*, 2011, Mulligan and Olsson, 2013, Paroutis *et al*., 2014). More specifically, the smart technology effect requires a three-

tier relationship of facilitating efficiency, in which smart is the enabler for that relationship (between individuals and the city's systems) and ICT is an instrumented data network that produces instant information that allows systems to automatically control it (Dohler *et al.*, 2011). Smartness, therefore, is considered as something beyond that which technology or data alone can provide, and thus the smart concept should take cognisance of individual and city wellbeing (De Santis *et al.*, 2014).

2.3.1.2 Business

Smart cities' organisational role between relationships could be built through real-time data creation, yet requires further conceptualisation, as the technology aspect is not enough for a city to progress the organisational management of smart cities (Doherty, 2013; Shelton *et al*., 2014; Calzada, 2015). In other words, the 'who, when, why and what' of management in smart cities needs consideration. Academics consider the role of economy as essential in smart city management and development, where the essence of smartness is perceived as an innovative way of supporting the infrastructural systems of the 'Triple Helix' – a three-part concept of i) small medium enterprises (SMEs), ii) universities and iii) government collaboration – in the smart cities urban experience (Lombardi, 2009). Therefore, often, the vision of smart is based on marketable solutions responding to fiscal opportunities, particularly in the contemporary context of economic decline, and future management opportunities (Kramers *et al.*, 2014; Paroutis *et al*., 2014;).

City innovation adopts a general approach towards the management of city life and is the enabler of the smart cities vision, entailing innovation divorced from technology – an innovative product draws upon social values to facilitate future city visions and collaborations between seemingly disparate sectors and stakeholders (Paskaleva, 2011; Auci and Mundula, 2012; Bencardino and Greco, 2014; Barlte *et al.,* 2018). In this collaborative context, innovation is the emergent vision in smartness and appears to suggest improvements as an organisational tool enabling, for example, resource security; hence, the technological aspects support only a part of the whole living qualities of a city, where innovation refers to a general new management approach to smartness (Reinwald, 2014).

2.3.1.3 Sustainability

Sustainability does not appear to explicitly incorporate technology in smartness as it does in the case of business. Smart cities that are both sustainable and smart reflect an idealistic perception of cities and people in a holistic view (Connelly, 2007; Lazaroiu and Roscia, 2012; Garau *et al*., 2014). Yet incorporating key elements of sustainability into smart cities can be perceived as complex, as smartness aims for both liveability and competitiveness whilst focusing on many aspects that sideline resource management (Monfaredzadeh and Berardi, 2014). If smart cities aim to deliver sustainability (and to address environmental challenges), then they require new configurations and a new social identity of the governance models and citizens who reside therein (Gabrys, 2014).

A primary characteristic of a smart city is increased efficiency of urban operations, which should be combined with improvements to the economy, sustainability, and liveability, and set within the context of a fairer society while providing a comprehensive approach to the plethora of urban challenges and their contextual relationships (Batty, 2012). Once again, these elements require a new pathway to define how smartness can create new opportunities, new networks, and prospects that turn a host of smart city initiatives into experimental high-quality city living spaces (Woods and Gartner, 2013).

Hall (2000) suggests that smart may become the coordinator of these operations, able to create optimal conditions for living quality in cities, based on engagement from a multi-faceted range of stakeholders collectively participating in bringing the wider vision of smart cities into fruition. Therefore, a general solution for the ‘meaning of smart’ problem would be to promote and action the idea through smart divisions that encompass fiscal, environmental, humanistic, governance and mobility aspects, focused on the betterment of life in cities and enabled by a collaborative sustainable system that uses a three-part participatory system involving: i) the applicability of innovation, where this knowledge will be applied to cities overall, ii) city governance, and iii) academic capacity to shape the focus of the operations arising from this relationship (Allwinkle and Cruickshank, 2011, Castelonovo *et al*., 2015). Smartness, therefore, is similar to sustainability and can be considered as the infrastructural interplay of societal and corporate factors, and collaborations that aim to bring

about effective urban management and contribute to innovation targeted at: advancing the quality of life of both individuals and the public as a whole; achieving good living and citizen involvement; and meeting environmental considerations whilst allowing for urban progress and life enhancements (Caragliu *et al.*, 2009, Harrison *et al.*, 2010). This could lead to more innovative technological and environmental solutions using a structured approach incorporating 'liveability embracing' in data management.

2.3.1.4 Life quality

Addressing the quality of life in cities requires a shift in focus of the urban realm (Exner, 2014). When making the connection between smartness and life quality, it is suggested that living quality is based upon how people embrace technologies and infrastructure(s), promoting citizen participation in city governance issues (Bencardino and Greco, 2014). Equally important when defining life qualities in smartness, the meaning has been formatted as a group of elements, with some academics suggesting that smartness can be conceived as a combination of sustainable and societal living, focusing on life qualities in the urban environment through technology and innovation (Mitchell, 2006). The humanistic ideal here takes a central role within a smart, societal view, whereas sustainability is often found in smart cities as an asset of urban space, along with contemporary technologies that enhance smart city living and life quality in cities, which is encouraging for the purposes of this research (Chourabi *et al.*, 2012, Moreno *et al.*, 2014).

2.3.2 Commercial

Companies and organisations appear to have undertaken comparatively limited and highly focused research on the meaning of smart cities, using digital services to measure city functions and often being influenced by the type of services and the size of an organisation (ITU, 2015). Arup describes smartness as a seamless city structure that is strategically connected with the use of technology (Buscher, 2010). In the quest to understand and operate smart cities, Arup has collaborated with academics in what is a positive collaboration between commerce and academia for the effective operation of smart. For example, the focus of smart for Arup is more on the process rather than achieving a specific aim or optimisation to impact on citizens, governance and businesses (Cosgrave

et al., 2015). For example, data for service efficiency, optimisation and organisation management can support new collaborations to achieve sectoral innovation of the smart city model. By achieving this, there is the potential for a positive influence on citizens and cities via efficiency, monitoring, climatic response and management (Webb *et al*., 2011).

IBM is considered one of the commercial pioneers of servicing smartness with projects in Europe and internationally (IBM, 2009; 2011; 2018). They introduced the 'Smarter Planet' vision in 2008 and since then many stakeholders have been involved in its technological systems and data. It is interesting to see that IBM has an understanding of a city as being the combination of a digital and physical connection, which also holds collective city data, i.e. it means to elevate the idea of a city as a whole through collective datasets (Harrison *et al.*, 2010). In particular, IBM (IBM, 2012) notes that cities need to propose their own visions of smartness, rather than following sets of available proposals which would show that a city can be independent in terms of services and operations. Burton *et al*., (2013) introduce the idea of the life quality of people in the city is linked to collaboration for continuous development. They consider innovation as a technological tool and focus on the aim of technological advancements, together with leaders of great vision, encouraging cities to become sustainable and resilient to enhance life quality (Burton *et al*., 2013). However, it can be concluded that IBM is a company that is interested in the expansion of servicing and delivering 'service resource optimisation' (where IBM is the service provider for these solutions), albeit that this is aimed at enhancing sustainability, economy and living standards in city infrastructures with the use of digital technology (Kehoe *et al.*, 2011).

Cisco is known for creating new developments of future cities, under the 'Cisco Smart Cities' agenda, to respond to urban challenges using advanced information technology to deliver efficiency. Although, these innovative solutions could potentially lead to addressing other challenges because they are not fully developed (Falconer, 2012).

The role of smart for smaller-sized companies is often focused on fragmented elements and is highly dependent on current technologies (Hamblen, 2015). For example, International Data Corporation (IDC) is an international advisory organisation focusing on technology strategy delivered

by digital interventions and perceives smartness as a governance tool for change empowered by technology (Anderson, 2013). In contrast, Fundación Telefónica, a technology-driven consultancy, focuses on digitalisation as being central to improving lives through environmental sustainability and the economy, but with the requirement that citizens should be part of the service by taking part in the governance of city resources (Azkuna, 2012). As the general understanding of smart turns to innovation, companies such as McGraw Hill want to enhance innovative thinking in their processes, with the integration of Building Information Modelling (BIM) and the Internet of Things (IoT) into urban planning (Doherty, 2013). Thus, a general move towards digitalisation, human ideals, and urban planning is seen in some service providing companies. The International Telecommunication Union (ITU, 2014), a commercial company that has been developing standards for smart cities, has also published a study on several definitions to understand smart and sustainable cities, which contains a collection of corporate, academic, ITU and industrial sector definitions. ITU explains how collaborations in the city expand these ideas on human relationships in the urban realm and express confidence in its structures with regard to the effective exchange and sharing of ideas (Hwang, 2013). Navigant Research, a consultancy company, promotes the amalgamation of technology aimed at delivering sustainability, wellbeing and fiscal advancement, where technologies can coexist and lead to innovations (Woods and Gartner, 2013). Fujitsu places intelligence at the heart of smartness and human society (Tamai, 2014). Steer, (previously called Steer Davies Gleave), a transportation-focused consultancy, prioritises liveability for smart cities through a car-free vision, which likely leads to improved economy and emphasises what people would like for a holistic, positive city living experience (Duckenfield, 2013).

Generally, in commercial definitions, we see larger organisations explaining smartness as coming from infrastructure service providing solutions, often based on digital infrastructures, though these are really a network of their services that are able to cover city needs and digital processes. On some occasions, although companies use the terms liv(e)ability and quality of life in their initial conceptualisation, most (if not all) of them have service provision as their goal, and hence profit as one of the most important elements in their smart visions; this would entail a constant judgement of

fiscal turnover, which places them far away from what liveability stands for. As Angelidou (2015) notes, smartness is strongly related to economic parameters, and despite many attempts to acknowledge this in smart cities, the elements are unclear in their definitions and the connections with liveable elements have not materialised, which can lead to confusing visions.

2.3.3 Governance

Smartness is an urban concept that influences cities nationally and internationally and is of paramount importance in terms of fundamental principles and service provision. New smart city operations are required to provide opportunities that combine replacing old administrative systems and being able to manage the city and bring it to a smart and liveable position (Toppeta, 2010). However, especially in the European Union (EU), cities have competing agendas that do not allow for the derivation of smart agendas. Sections 2.3.3.1, 2.3.3.2 and 2.3.3.3 in this thesis critically review some of these attempts at UK, EU, and international city levels.

2.3.3.1 UK

There are two main government organisations that have been involved in the UK smart agenda: The Government Office for Science, Foresight project teams and the British Standards Institution (BSI). The Foresight Future of cities project refers to data as being vital for smart cities, combining to organise the socio-political foundation of the city as a structure (Moir *et al.*, 2014). However, the BSI response to smartness has been more explorative: describing smartness is a process, a result of which, cities become better prepared to deal with existing and future problems, with participating citizens and sectors coming together to develop a sustainable-smart growth for an all-encompassing human environment (BIS, 2013). The Publicly Available Specifications (PAS) published by the British Standards Institute (BSI) series (PAS 180: 2014; PAS 181: 2014; & PAS 182: 2014) refer to the challenges UK cities face when using innovative smart techniques to help deliver their visions of efficiency and sustainability (BSI, a,b,c,d). The meaning of smart here becomes specifically a systematic vision of smart as data innovation and integration, while referring to a citizen-centric approach, yet how people are part of this system is not explicitly described (BSI:181, 2014).

2.3.3.2 European Union (EU)

The EU as a collective structure describes smartness as an incremental process for cities, where smartness is conceived as an organisational approach, a network of parts that communicate and improve city living within an array of socio-economic layers (EU-Commission, 2012). The 'European Innovation Partnership on Smart Cities and Communities' (EU EIP-SCC) was formed in order to advance smart city living through interactions with sustainability, but most explicitly, economic development, i.e. it focuses most explicitly on the economic pillar of sustainability as the way to support the economic development of European cities (EU EIP SCC, 2013;Manville *et al.,* 2014). In 2013, smartness was perceived within specific topic areas: economy, people, governance, mobility and environment (EU EIP-SCC, 2013). Therefore, we start to see those smart cities adopt a dynamic notion that could transform from having information technology as their main smart element to embracing stakeholder-governance collaboration, resulting in facilities for governance improvement in societal terms (González and Rossi., 2011). Along with the smart agenda, collaborations are extending between nations internationally; for example, the EU-China collaboration envisions smart cities in terms of the management of resources, and information management frames smartness as a value infrastructure using developed technological systems (Kang *et al.*, 2014).

2.3.3.3 Cities (international perspective)

In this research, four cities (Birmingham and London in the UK, Copenhagen and Singapore) are explored as case studies. Birmingham was chosen as a primary case study for this thesis since much parallel research has provided a strong foundation to support the analysis (e.g. it was one of the main study cities of the EPSRC 'Liveable Cities' programme and was the subject of diagnostics research in an RCUK and Innovate UK Urban Living Partnership pilot research programme). Moreover, it is currently undergoing major development (Hawksworth *et al.*, 2017) and, starting from a very different (industrial manufacturing) historical context, as the UK's second city, would provide a good comparison, in terms of future visioning and its smart agenda, to London, the UK's capital city, which lays claim to many innovative smart initiatives. A third smart city example (potentially outside of the UK but of a not dissimilar scale, so as to provide a further variation in historical and cultural context)

was originally considered desirable as an additional comparison to the UK cities case studies, however, due to the complexity of how smart is perceived by other cities (Cohen 2012b; Cavada *et al*., 2014), two renowned smart cities are used in this research instead. This helped to provide more clarity by exploring two very different liveable approaches to smartness: Copenhagen, a smart city internationally renowned for prioritising life quality in its smart agenda and winner of the Green European Award (Cohen, 2012b; EGCS, 2014; Hansen, 2012); and Singapore, a 'city-state' that has followed a different smart agenda, based on digitalisation, to become a world-renowned smart city, thus would enable exploration of the effects of digitalisation on liveability (Cavada *et al*., 2016; Cohen, 2012b). More specifically:

i. Birmingham is implementing smartness according to the UK Government Department for 'Business, Innovation and Skills 2013' description of smart cities, aimed at liveability, inclusivity, and resource security (DB, 2017a).
ii. London recognises smartness using ICT for high-quality city growth, where a collaboration network is essential. Although the leadership of the city changed during the course of the research, this remains the proposed 'meaning of smartness' under the new governance leadership (A smarter London together: GLA, 2018a; see also Cohen 2012a, 2014).
iii. Copenhagen's plan of becoming a sustainable city has been being formed over the last two decades and has helped it to become an international exemplar smart city, having a clear focus on sustainability as the way to become more liveable. This has been achieved by interweaving information technology into the city environment, by being efficient and by the successful exchange of ideas in its society (Mortensen *et al.*, 2013b).
iv. Singapore has adopted a well-defined idea of smartness in Smart Nation Singapore (SNS), where technology is explicitly used for life improvement and community enhancement (SNS, 2018).

The initiatives that have been adopted to make these cities 'smart' are discussed in detail in Section 2.3.4.

Views on smartness from other cities also help to establish what is truly smart. Bilbao is a city that seeks improvement through a collective of thematic subdivisions and the relationship between them, where people should act as participants in a community that manages resources efficiently (Azkuna, 2012). Vienna has adopted an approach that is focussed on the economy and policy of the EU in terms of management rethinking and people involvement. Although, it has not yet implemented the approach as a strategic technical solution (Mortensen *et al*., 2013b). This is an indication that cities are finding their own formula of how to become smart, and that they recognise that there is an element of risk involved in the liveable realm and with decision making for a shared liveable approach. Some city organisations have pointed out that, although the various smart cities prioritise different (and sometimes ambiguous) technology and target segments, there is some common ground appearing; for example, to have ICT as the tool to solve urban challenges related to the economy, society and sustainability (Nohrová, 2014).

2.3.4 Initiatives

Albino (2015, pg. 13) explains the difficulty in attempting to operationalise and measure smartness, suggesting that "*smart city initiatives*" (in the case of Birmingham, they are also called projects) have, so far, been one method to assess cities that call themselves smart, a method also used to rank smart cities (Alawadhi *et al.*, 2012). Initiatives, according to the European Union Commission (2016), enable citizen participation in city operations, hence facilitating democratic participation, which this research considers a fundamental enabler for smartness in cities. Smart city initiatives are a way to bridge the uncertainty of what smart is; they are considered to enhance peoples' ownership of the development of the city administration agenda related to liveable solutions, and to support them using big data and metadata systems (Neirotti *et al.*, 2010; Marsal-Llacuna *et al.*, 2014; Cavada *et al*., 2017). Similar to their use of initiatives as a method to assess smartness, this research adopts initiatives as a way to understand how smart cities operate.

2.3.5 Smart Cities Meaning Conclusion

This critical review of the meaning of smart cities confirms a disparity among the discussions by the three groups (Academic, Commercial and Governance), which suggests differences in the goals of

each group. In general, smart cities lack a universal definition of liveability, and, more specifically, the term smart is open to different interpretations according to a group's or individual stakeholder's agenda. In the next section of this chapter, the research analyses existing examples of smart cities in order to understand if smart approaches have enhanced liveability, through their vision, initiatives, and funding. It would seem that 'sustainable' is the most prevailing of the themes, which could be linked to liveability. However, according to Jong *et al.*, (2015) 'smart' has moved beyond 'sustainable' as a new theme among the thematic cities that have been discussed in the academic realm. Further exploration of the operations of what is claimed, or considered, to be smart cities should reveal the 'liveable intentions' in the smart cities realm.

2.4 Smart Cities Exemplars (Step 3)

In this section, four smart cities are explored in order to give an insight into whether they are considering liveability in their smart vision (Schaffers *et al.*, 2011). This research is focused on the UK context, thus, for reasons outlined in the previous section, Birmingham was selected as the first example of a smart UK city, while London is the second, due largely to its adoption of the Smart London Plan as a complete approach to city smartness. Two additional examples – Copenhagen, a European city used because of its efforts in liveability (Mortensen, 2013b), and Singapore, which has developed a vision beyond the city context of smart to the Smart Nation (Foo and Pan, 2016; SNS, 2017) – are provided by way of international comparison. Importantly, smartness, like the themes of sustainability and resilience, is determined by the local context (Rogers, 2017), and each has a very different historical context.

2.4.1 Birmingham

The Huawei-Navigant Consulting Inc. report on UK smart cities ranked Smart Birmingham as a '*contender*' among the four ranked groups of '*followers, challengers, contenders, and leaders*' (Woods, *et. al.,* 2017; Navigant, 2016, p25-7). Birmingham has structured a smart approach around its City Council (BCC), where Digital Birmingham (DB) is the main stakeholder for the Smart City Roadmap (SCR), along with the Smart City Commission (SCC), which is focusing on resiliency and

allowing citizens' involvement by implementing internet connectivity and a sustainable vision through the Green Cities Commission (DB, 2017a; DB, 2018a).

2.4.1.1 Vision

Birmingham's SCR envisions three main pillars in the core of Smart Birmingham, where each category includes the subcategories: i) technology (connectivity, planning for digital infrastructure and information marketplaces), ii) economy (health, wellbeing and care, ICT and energy efficiency and mobility), and iii) people (digital inclusion, skills and employment and innovation) (SCR Smart City Roadmap, 2014). One of the fundamentals set by DB is '*citizen engagement*' (the other three are '*integration, digital and data*') and it refers to citizens (along with commercial organisations) as the enablers of city processes (DB, 2017a; 2018a), an idea that is considered in this thesis to be part of the route to liveability.

2.4.1.2 Initiatives

As expected (due to the smart agenda being generated by DB), many initiatives in Birmingham are connected to digital technologies. For example, central areas in Birmingham allow free of charge access to the internet, aiming to help people gain employment, and provide other information on the city (DB, 2018a). Birmingham Data Factory (BDF) is also aimed at citizens (or those interested in) sharing open datasets online that contain information on, for example, Council matters, mobility, sustainability, finance, learning and liveability (BDF, no date). Furthermore, the Birmingham Green Commission aligns to the guiding principles of sustainability, lower carbon emissions and environmental finance (Sustainability and Green Commission, BGC, 2017a). The Birmingham smart cities projects belong to four categories: the first aims to support liveability and wellbeing (e.g. Horizon 2020-H2020- City4Age, H2020 Participatory Urban Living for Sustainable Environment, Digital and Financial Literacy Birmingham); the second, investment and Small Medium Enterprise (SME; e.g. Pure Cosmos, Eastern Corridor); the third, data (e.g. Open Data, Big Data Corridor); and the fourth, mobility (e.g. Smart Routing, High Speed 2 -HS2- Digital Future Prospectus) (DB, 2018b). All SCR initiatives are further explored in the analysis described later in this thesis.

2.4.1.3 Funding

Birmingham's funding is framed around four main resources, linked into an "*ecosystem*" in the SCR. These are the Research Council (RC), European Union (EU), National Authorities and Other Funds (Greater Birmingham and West Midlands, for example) (DB, 2017a,b). So far, Digital Birmingham has received UK and EU funding from Innovate UK, the European Development Fund- EDF and the European Social Fund Government Super Connected Cities programme under the European Competitiveness and Innovation programme-ICT for Energy Efficiency (DB, 2018b; EUCIS 2011). A £1.5 million venture from the UK Government enabled Birmingham to provide free internet access in central parts of the city (DB, 2018b).

2.4.2 London

London has been pursuing smartness both to support the local needs of the UK capital and to advance as a worldwide capital, expressed in the Smart London Plan and the Smart London both of which are accessible online from the Mayor of London (MoL, 2013; Smart London Plan, 2013). The (first) Smart London Plan (SLP) was issued under the London Mayor in 2013, harnessing contemporary technologies to improve the capital; it demonstrates the main pillars for Smart London, putting individuals and companies at the centre of the plan (Smart London Plan, 2013). These documents provide a holistic picture of the aims of Smart London and will be explored further in the course of this research.

2.4.2.1 Vision

Due to a recent change in mayoral leadership, the dynamic plan for smartness has been open for (UK) public consultation, whereas one of the aims of Smart London is to get international acclamation using digitalisation to improve liveability, employment, and finance (MoL, 2017a). Four pillars support the vision – "*open data & transparency, technology & innovation, efficiency & resource management, and collaboration & engagement*" – and all are connected at the core of the betterment of living in London (p18, Smart London Plan, 2013). For the first time, under the new leadership, London has assigned a Chief Digital Officer-CDO to deliver the smart vision (MoL, 2017b).

2.4.2.2 Initiatives

This thesis explores Smart London in relation to the currently published initiatives (the first quarter of 2018) - these are accessible from the Mayor of London's web page in the sub-division: '*business and economy*', where the SLP is also accessible (MoL, 2017a). Currently, Smart London supports seven areas related to smartness (A Smarter London, Chief Digital Officer, Smart London Camp 2018, Smart London Board, Working with the Boroughs, 'The Mayor and Smart', and London Datastore), seemingly related to governance and digitalisation. Especially in 'The Mayor and Smart' area, initiatives are using digital implementations for energy, pollution, mobility, and education (MoL, 2017b). These are the initiatives that this research focuses on to assess whether London is truly smart, and will be explored in detail in the London case study.

2.4.2.3 Funding

Juniper Research (2017) suggests that funding for smart cities will be compromised if the UK is not part of the EU, mainly due to the curtailment of funds from Horizon 2020. Smart London channels funding from the government for industries related to smartness, for example, the Smart Mobility Living Lab London (Living Lab ^{TM}, 2017). Yet the main funding body for smart cities is Innovate UK, (the UK Research and Innovation agency, Innovate UK, 2018a) which perceives smart cities as being part of the UK infrastructural system and this is listed as one of the four focus areas; the other three are: energy systems and supply, transport systems and urban living (Innovate UK, 2018b). Additionally, Innovate UK funds individual projects and companies that could contribute to smart cities in respect to the implementation of digital technologies; these funds are won via applications or competitions. For example, 'Smart Environments' (part of Smart London) has acquired funding from Innovate UK and was the winner of 'Mayors Entrepreneur 2017' (MoL, 2017c).

2.4.3 Copenhagen

Copenhagen's progressive attitude towards liveability is shown, for example, by its promotion of alternative transportation for almost five decades (mainly bicycles), which has had a positive effect on city space, infrastructure and social connections (Carstensen, 2015). Liveability played a major role in it becoming a smart city. Copenhagen was listed in the world ranking of smart cities early on (Cohen,

2012b; Riello, 2014), and later, in 2013 and 2014, was announced as the first 'Smart city in Europe' (Cohen, 2014). Since then, in 2014, at the 'Smart City Expo' world congress (Smart City Expo, 2014), it gained the best 'World Smart Cities Award' for its 'Copenhagen Connecting' plan (State of Green, 2014). Also in 2014, Copenhagen was the winner of the World Smart City competition (Visit Denmark, 2015) and was awarded the Green Cities award (European Green Capital, 2014). In 2016, it was voted eleventh of the world's smartest cities (IESE, 2016) and top in the world due to its green strategy (Kwang, 2016).

2.4.3.1 Vision

Copenhagen is considered to have advanced its overall life quality through liveability and sustainability (in accordance with Copenhagen's 2025 vision), enhancing diversity in employment, learning, daily life and discourse to deliver overall benefits through employability and a strong economy (OECD, 2009). As Figure 2.2 shows, the main goal is quality of life and growth in a green city achieved via focus areas (blue) and the underpinning ideas (orange), one of these being smart city infrastructure.

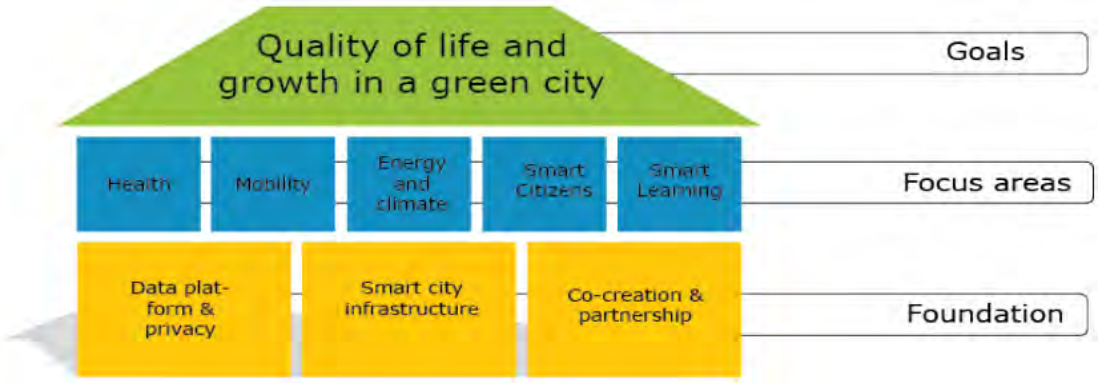

Figure 2.2: Smart City Strategy Copenhagen (Lea, 2016)

This vision was linked to a set of connections with academic research and marketable solutions (associated with private companies and investors) and supported by the central government, under the 'Energy Agreement' for achieving green energy through private investment and policies (Ministry Foreign Affairs, 2011; Hestbæk, 2012). Copenhagen then focused on growth, digital monitoring and data collection as a way to enhance governance participation and, as the 'Carbon Neutral by 2025' plan extends to city administration, academia and corporations, collaboration via a cross-sectional

approach of carbon emission initiatives for innovative strategies, employment opportunities and assets (Gilles, 2012). In 2013, collaboration with IBM's 'Smarter Cities Challenge' suggested a citizen-driven approach, breaking down the existing silos of the dataset system – the Open Value Network (Gandhi *et al.*, 2013).

2.4.3.2 Initiatives

Apart from cycling (which might be allied to walkability in 'social cities', see Table 2.1) being the main mode of transport, Copenhagen shifted its focus to cities rather than regions of the state, enabling connectivity, where technology could facilitate much of the operations, allowing for easier and faster collaborations (Mortensen *et al.*, 2013a). Further implemented initiatives include the application of sustainable practices in the area of Nordhavn as a test-bed area, with lighthouse projects on energy, mobility, buildings and the incorporation of climatic considerations for future thinking as a systematic approach to the greening of Copenhagen (Sylvestersen, 2009). Greening is also presented as a development for fiscal prospects, not only to lower carbon emissions, but also to create a liveable and pleasant area, demonstrating Copenhagen as a green city of technology and liveability; for example, these principles can be observed at Brygge Harbour Bath, currently a centre of attention for people and businesses (Jensen, 2012).

2.4.3.3 Funding

Copenhagen has achieved a form of liveable city living that is widely publicised and achieves ever-rising real estate prices. Its strategies are widely known, for example, cycling, locally networked heating in almost all residences and all citizens being in close proximity to a leisure neighbourhood. As such, early on it was named one of the most liveable cities in Europe (Wiking, 2011). Since then, Copenhagen's liveability strategies have been enabled by funding based on the green fiscal prospects of green goods; one in ten of the workforce is involved in the 'green industry' (for example, smart homes); goods were not purposefully designed for climate adaptation, but have been adjusted to the current climatic needs and adapted so that they adhere to the carbon emission strategy (DM, 2012, HOFOR, 2016). Overall, the Danish economy advanced by a 121% surplus in energy supply (2010),

compared to 52% in 1990 and 5% in 1980, and a wind turbine capacity of 27.7% in 2010, in comparison to 3.8% in 1990 and 0% in 1980 (Danish Ministry Climate, 2010).

However, a clearer vision for Copenhagen could and should be implemented; one that focuses on diversity and people, as often the city vision is blurred by investment opportunities and they disregard the real meaning of smart; efficiency and technology can distract from the purpose of why innovative strategies should be adopted for cities to operate as truly smart cities (Gilles, 2012).

2.4.4 Smart Nation Singapore

Singapore's location in Asia was its primary asset in the 19th-century trading era, but cheap manufacturing in the 1960's and the production of digital products in the mid-1980's led to a flourishing IT infrastructure, and significant economic development (Mahizhnan, 1999). Since then, Singapore has grown from a country of limited opportunities into a contemporary nation that has become globally renowned and increasingly smart (Warwick, 1998).

Efforts by Juniper Research Limited (a consulting firm focussing on digital products and telecommunications) suggest it was the first smart city, and Singapore is often included in the worldwide smart city rankings (Smith, 2016). For example, it was ranked first in the world's top five smart cities (Buntz, 2016) and was a big winner (along with New Zealand – similar to Singapore also a nation that devotes much effort to smartness) in the IDC Smart city development index *(Afuang et al.*, 2017). Consequently, Singapore is often considered the smartest city (Watson, 2017).

2.4.4.1 Vision –A Smart nation

Singapore's vision to become a leader in terms of quality of life was initially conceived during the 1980's in the form of the Government's Information Technology Plan to improve services, which led to increasing socio-economic opportunities in governance advances, technology and industry collaborations (Foo and Pan, 2016). Singapore has scaled up its ambitions from being a smart city to being the first Smart Nation, focused on citizens and businesses, with input that will enable innovative actions and government regulation (SNS, 2017). Delivery of the digital transformation was enabled by the Infocomm Media Development Authority (IMDA), a government regulator for digital innovation, and was supported by GovTech Singapore (IMDA, 2018; Gov Tech Singapore 2016). The IMDA

(2018) published the 'Intelligent Nation' report, a collection of endeavours for the 2025 governance plan vision, as seen in Figure 2.3, based on "*innovation, integration, internationalisation*", to enhance liveability through information technology learning, the supply of laptops and internet access for everyone; and digital healthcare and governance, aiming to spread the benefits of technology to the wider society (iDA, 2008).

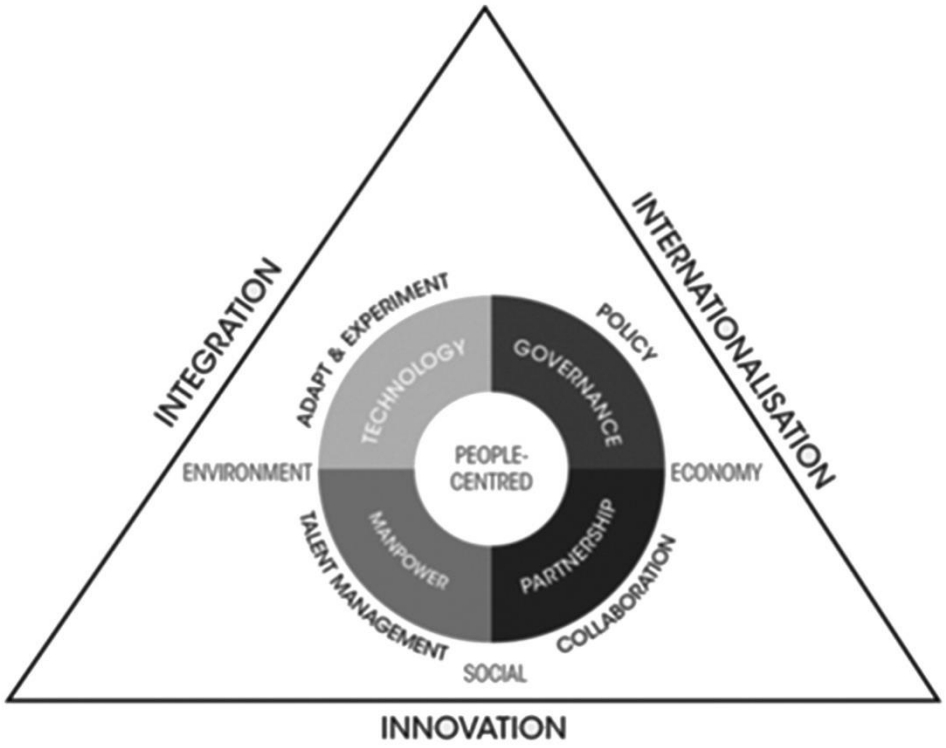

Figure 2.3: Framework Singapore Smart City (Foo and Pan, 2016)

Smart Nation Singapore, therefore, is a long-term plan and continues to address challenges at a governmental decision-making level to emphasize digital infrastructure interventions, and improve citizens' lives (Hoe, 2016).

2.4.4.2 Initiatives

Singapore's step-wise view of a Smart Nation is documented on its website and recognises four pillars of initiatives (Health, Living, Mobility, Services) to address ways of improving quality of life issues through the implementation of digital technologies (SNS, 2017). According to the website, mobility and service initiatives have adopted technological advancements to improve transportation with driverless automobiles and real-time data analytics, whereas healthcare and housing can be considered the main focal points of standards of living/quality of life. Further initiatives, promoting a car-free

agenda, contribute to the smart and liveable agenda through local initiatives and car ownership being "*from 0.25% to 0%*", according to the Land Transport Authority Singapore LTAS (URA, 2018; LTAS, 2018). Initiatives promoting human capacity and commerce also extend to the support of younger generations, from the National Youth Council NYCS (supported by the central government) and in collaboration with Spring Singapore, supported by the Ministry of Trade and Industry for collaborations, development programs and finances (National Youth Council, 2016). It is evident that government collaborations have developed through the Research, Innovation & Enterprise RIE 2020 Plan, arranged in four areas – scientific collaboration and scientific funding from the government; collaboration with the commercial sector for fiscal gains; and empowerment of the human workforce. One of the main scientific collaborations is the Singapore-MIT Alliance for Research and Technology Innovation Centre SMART (SMART, 2016).

2.4.4.3 Funding

Smart Nation Singapore's (SNS, 2015) efforts to create a liveable and economically successful nation are organised by the Government of Singapore. The financial aims of the 'Research, Innovation and Enterprise' (RIE 2020) scheme prioritised government funding for early-founded businesses, and collaborations to enhance knowledge, investment and confidence in industrial involvement (NRF, 2016). Reforms and the effects on the economy of collaborations involving private organisations such as Cisco working with Singapore's Smart Nation showed that, in 2014, the fiscal advantages of digitalisation would exceed US$4.6 trillion within a decade, arising from 40 smart cases that promote innovative systems in engineering, health and trade, and bridge further collaborations of the IDA and the Ministry of Communications and Information (Bradley *et al.,* 2014). The National Research Foundation (NRF) has also focused on fiscal efforts; supported by the government in the 'Innovation & Enterprise Cluster Fund' manufacturing scheme, with $54.4 million of funding for industry-led projects (NRF, 2017; 2018).

2.4.5 Conclusion Smart City Exemplars

This literature review has explored four smart cities – Birmingham, London, Copenhagen and Singapore – in terms of vision(s), initiatives and funding in order to understand whether their smart

agendas impact on liveability. These four smart cities demonstrate some movement towards liveability and it appears that all of them have used digital technology as the means to do so. Birmingham considers digitalisation to be central to liveability, quite similar to London's approach. Copenhagen's 'smart' growth focussed on environmental sustainability initiatives, whilst, in contrast, Singapore focussed on digitalisation, forming a digital culture that was able to advance citizens as technologically progressive users to achieve its smart vision (Benner, 2016; Sridharana *et al.,* 2007). This strategy has led to a digital entrepreneurial spirit therein and international recognition, not only of a smart city but of its advancement towards becoming a smart nation, all of which has been supported by the General Government. However, this was made straightforward by Singapore being a 'nation-state'.

Likewise, Copenhagen developed environmental solutions in commercial areas while capturing knowledge from the implementation of the solutions, and this framed the city as an international destination in terms of environmental sustainability. There is also a strong connection between the outcomes of both places due to the fiscal opportunities offered by the smart vision; Copenhagen has gained from realising low carbon emissions, whereas Singapore has gained through its transformation into a digital nation.

This research recognises that, in the same way, that smart city exemplar initiatives find it difficult to explicitly define 'liveable', descriptions of smart cities themselves are not adequate enough to enable a truly complete comparison. For this reason, the next section outlines various tools that exist for measuring smartness, which can reveal another layer of recognising truly (liveable) smart cities.

2.5 Conclusions

Cities nowadays have exceeded human expectations (at least in terms of spatial development and technology) of simply living and working, but also face challenges that seem inevitable and difficult to overcome without rigorous planning. This thesis considers cities to be the agents to overcome these challenges. Smart cities are called for to respond to the plethora of challenges, yet cities are approaching these challenges in different ways rather than adopting a single, unified approach. This thesis is exploring smart cities through the lens of liveability and, in support of this; it has critically

reviewed the meaning of smart cities, and examples of smart cities, in order to ascertain the pervasiveness of liveability allied to smartness in the literature. Specifically, the review has crystallised the following points:

i. The thematic approach of different city types shows similarities and overlapping agendas, and the benefits gained from addressing climate change and city living challenges.

ii. The meaning of 'smart' in smart cities varies according to those talking about smartness. For example, academic views are critical of the liveability effects of digital technology; profit could marginalise liveability for commercial organisations; and governance aspirations for smartness are context, vision (or theme) and stakeholder dependent.

iii. Birmingham, similarly to London, views smartness through digitalisation (i.e. generally adopts digital implementation of solutions), whereas Copenhagen prioritises sustainability – a notion that has several similarities to liveability – and Singapore is a pioneer of the Smart Nation, offering digital governance services to citizens.

To build on this review, Chapter 3 provides a critical analysis of the assessment tools to conclude the literature review of smart cities research.

CHAPTER 3: CRITICAL ANALYSIS OF THE ASSESSEMENT TOOLS AVAILABLE

3.1 Introduction

The literature review showed that cities generate themes that relate to the challenges these cities face. According to these themes a city would develop a vision to overcome their challenges and according to the literature this is often aimed at the betterment of living in the urban context. This has helped cities to realise their capabilities and apply them to overcome these challenges. Specifically, smart cities often address environmental and governance issues. The literature also showed particular academic criticism based on the lack of definition and explicit meaning of the term smart. For this reason, it was proposed that the meaning of smart was explored through academic, commercial, and governance stakeholders' views. This categorisation is followed in this chapter, to group the available tools and critically analyse them.

Sustainability is a common theme in cities. Here a broader view of liveability is used to assess smartness in terms of whether they are truly smart. Chapter 3 is a review of existing tools that aimed to find the most appropriate tool to assess the liveability of cities (hence assess true smartness) as well as being able to assess those initiatives developed in a city's smart agenda. The literature research on the four case study cities revealed that cities like Birmingham and London aimed at promoting liveability, Copenhagen focussed on environmental sustainability – which was also used as a platform to develop commercial solutions and support the local economy – and Singapore adopted a digital approach with support from the central Government. A good tool for this research was considered one that is openly available and self-explanatory to use, since this would facilitate effective democratic participation in a city becoming truly smart. The vision of the four smart cities in Chapter 2 showed that these cities would need to be assessed in terms of their environment, governance, and commercial (or economy in general) elements of smartness and how these affect the overall population. Therefore, a good tool was considered to be one that is able to assess any city in similar cases of smart cities initially explored in this research, using initiatives from their proposed smart agendas.

Overall, this research aims to examine the specific benefits in terms of individual, societal, and planetary well-being in cities. It is important that the tool can be used by city experts to provide a transparent assessment and to create an easy-to-understand process that they can convey to wider audiences. Additionally, the assessment criteria need to assess the liveability of smartness in the broadest sense—not in siloed terms of smart, such as smart governance or smart citizens, since this can add further confusion to what the terms might imply. The following sections in this chapter critically analyse the most promising tools, mainly to identify whether the categories (and, in some cases, the indicators used) are able to assess liveability, while also providing the other required features (such as accessibility and public participation capability), therefore constituting a useful and effective method of assessment for truly smart cities.

3.2 SPEAR®

Long before the smart cities vision emerged, assessment tools were used to attempt (through the use of performance indicators and metrics) to measure different aspects of city progress (e.g. Gross Domestic Product-GDP, crime rates) and infrastructural relationships, addressing differences in both context and local conditions (ISO, 2014). For example, a tool that was widely used prior to the recognition of the necessity for smart assessment and targeted sustainability assessment (here, in projects) that might achieve such an assessment is the Sustainable Project Appraisal Routine (SPeAR®), which was created by Arup and organised the assessment into categories, as shown in Figure 3.1 (Arup, 2013).

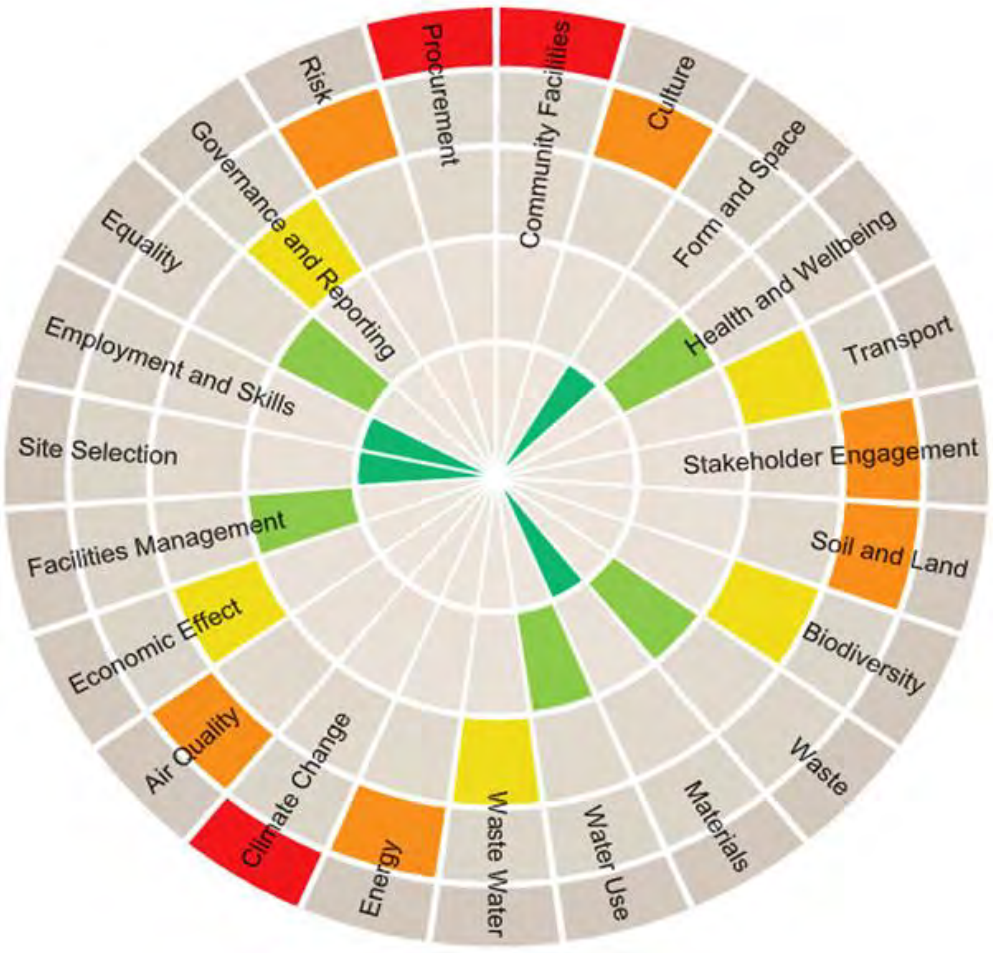

Figure 3.1: Sustainable Project Appraisal Routine (SPeAR®), Arup (2013)

SPeAR® was chosen for review due to the similarities between sustainability and liveability and for this reason is explored outside the 'academic-commercial-governance' categorisation. It provides a good basis for assessment in terms of sustainability for individual projects (McGregor and Roberts, 2003; Arup, 2013). Boyd (2004) suggests that sustainability cannot be assessed as a whole system; SPeAR® takes exactly that approach, evaluating each project as part of a gradual method to reach the overall goal of a sustainability evaluation. However, sustainability, although it undoubtedly includes liveability, cannot be used exclusively as an assessment of liveability unless there are explicit attempts to include the aspects of individual and societal wellbeing, and the factors that influence it. Although it it might be considered generally a good example of assessment, and some similarities can be drawn in some of the categories to other assessment tools (described below), SPeAR® is only able to assess smart city projects from a single sustainability view. Since this thesis aims to describe and implement a holistic approach to smartness, the use of SPeAR® in its current form would only be of partial use in

the assessment. It does not, therefore, allow the hypothesis of this thesis to be tested, nor can it be applied, certainly in its current form, to the initiatives of smart cities. The reasoning behind this conclusion is based on the fundamental aim of SPeAR®, which is to provide a balanced, visual overview of the impacts that a project has had, or is expected to have, relating to the three pillars of sustainability (economic, social and environmental) and natural resources. Informing a visual overview, segments combine factors (or indicators, or performance parameters) and thus, liveability, as defined in this thesis, might either be reduced to a single segment or be influenced by a number of 'social segments', while aspects of planetary wellbeing would be covered in a number of 'environmental segments' and 'resource segments'. In short, the definition of 'social segments' would have to be rethought to include individual wellbeing alongside societal wellbeing; the 'environmental segments' and resource segments' would have to be explicitly redefined, and the number and distribution of segments would need to be adjusted to deliver a balanced outcome in terms of liveability. While this has been done elsewhere to address specific issues of underground space (Zargarian *et al*., 2018) and street works (Hojjati *et al*., 2018), because they relate to aspects more aligned to a construction project, rather than being more generally initiative-based, it would not be the ideal means of assessing liveability.

3.2.1 Academic

This section is the first part of the 3-part categorisation. Here, two tools developed in academic research are explored to determine if and how liveability is part of the smart cities assessment. These are the Smart City Network model and the Smart City Wheel.

3.2.1.1 Smart City Network Model (SCNM)

This is considered an early assessment method in academic smart research and uses the Analytical Network Process (ANP), a process that examines the relationship between the parts to explore the connections that exist within other city themes in relation to smart, as the basis of a decision-making process for understanding the aspects of smartness (Lombardi *et al.*, 2012). The relationships between five proposed smart categories and city themes (Connected, Entrepreneurial, Liveable and Pioneer cities) relate smartness to a city vision (here, similarities can be drawn to the thematic city approach

discussed earlier in this chapter, in Section 2.2.1) that can provide an additional perspective of smartness so that it can be adopted in the decision-making process, as shown in Figure 2.5.

There are five main smart categories (Governance, Human Capital, Environment, Living and Economy), which are assessed across four sectors (Academic, Government, Civil Society, and Industry), according to Lombardi *et al.,* (2012), as shown in Table 3.1. Each category can provide evidence for smart practices across the four sectors. Of the five smart categories, some could potentially relate directly to liveability: Human Capital, Environment and Living. Smart Governance and Smart Economy are highly focused on digital systems and evidence showing how these categories are liveable have not been established, therefore it is not possible to be sure that this assessment will assess liveability entirely. The liveability aspects shown in: education, people's eligibility to vote, the languages spoken in the sectors and entrepreneurship (in Smart Human Capital); projects and grants, urban and cultural space, and business training (in Smart Living); and CO_2 emissions, environmental issues, mobility and decision making, and energy (in Smart Environment). Although the notion of liveability is present here, further exploration of the indicators used to assess these categories is needed to establish whether they can yield the desired liveability outcomes.

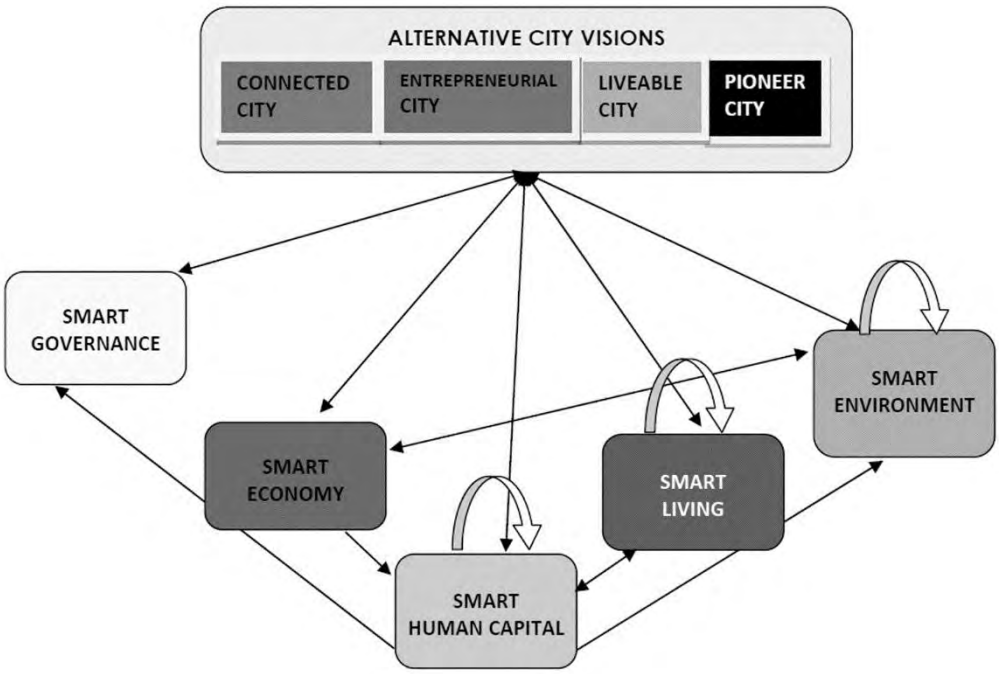

Figure 3.2: ANP Network example of connections and hierarchies between city visions and smart categories, adapted from Lombardi (2011).

Notably, some of the indicators also need exploration to examine how they might change in due course. For example, one of the indicators in the 'Smart Human Capital' category (in the Government Sector, see Table 3.1) points towards gender equality in the organisation of smart cities, an aspect also supported by the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2007), for females to pursue 'science, technology and policy' along with programmes empowering females in technology and science; however, gender empowerment (which also contains further issues in its own right) is unclear in terms of its effects on the delivery of smart cities, and indeed should be rooted in every aspect of indicators (ECWT, 2015; SEiSMiC, 2015; EPWS, 2018).

Lombardi's (2011) ANP approach contains some aspects of liveability in three of the five smart categories of the assessment – for example, in Living and Human Capital, and, more indirectly, in Environment – and how the ideas in each category can support each sector's decision approach. Thus, while the categories do not address liveability explicitly, the positioning of the discourse encourages decision making. This is an effort to relate a smart city to the other four thematic city themes (Connected, Entrepreneurial, Liveable, and Pioneer). Liveable, being one of the themes, shows that liveability has been considered as an alternative to smartness. This thesis could consider this the single aim of this tool (and disregard the other three), which then mean that smart city elements have to be considered as one of the five categories (Governance, Economy, Human Capital, Living and Environment). One can see that this could create unclear dependencies (similar to other tools explored in this thesis). A single view on the liveability of the ANP tool can distort the possibilities of the tool itself, as proposed by Lombardi (2011). Furthermore, deeper exploration of the indicators shows that they do not align at all well to the definition of liveability used in this thesis, and the subsequent categorisation of the indicators in four divisions – university, government, civil society, industry – further clouds this picture. It is evident that the ANP tool is accessible and shows clearly the sectors—these are formed as five smart categories, this is a silo approach that this thesis avoids.

Table 3.1: Performance indicators according to categories and sectors (Lombardi *et al*., 2012)

Category / Sector	**Smart Governance**	**Smart Economy**	**Smart Human Capital**	**Smart Living**	**Smart Environment**
University	Universities. Digital courses.	Public expenditure on R&D / education. Research grants funded by international projects.	15-64 with secondary education / higher education. Inhabitants working in education and R&D.	Professors / researchers in international projects. Grants for international mobility. Accessible courses.	CO_2 reduction strategy. Energy efficiency standards for buildings.
Government	e-Government online availability. Households with computers /internet access.	GDP. Debt of municipal authority. Average disposable household income. Unemployment. Energy intensity of the economy.	Voters in national and EU parliamentary elections. Share of female city representatives.	Recreational / Green space access. Public libraries /theatres /cinemas. Healthcare. Tourism.	Energy consumption. Efficient electricity. Water consumption. Efficient water. Green areas. Gas emissions. Urban sprawl. Environmental performance. Exposure to air pollution.
Civil Society	e-Government usage by individuals.	% of projects funded by civil society.	Foreign language skills. % life-long learning. Computer skills. Internet skills.	Book loans and other media. Museum visits. Theatre and cinema attendance.	Working population on public transport. Participation in environmental decision-making / environmental activity.
Industry	Research grants funded by companies, foundations, institutes.	Employment rate. Manufacturing High Tech & ICT products. Companies on national stock market. Domestic material consumption.	Patents. Employment in knowledge-intensive sectors.	Enterprises adopting ISO 14000. Industry based training.	Energy from renewable sources. Combined heat /power generation. Recycled waste. CO2 emissions. New buildings /renovations assessed in terms of sustainability.

However, the ANP comparison aims to highlight the focus on the relationships of a smart city (as a Connected, Entrepreneurial, Liveable, or Pioneer city) and to give a clearer direction for the future trends of smart cities, which might be a good addition for an assessment tool. The pairwise

comparison of the smart categories, mapped against the city themes may indicate the type of smart city that is being generated, and in turn, show which city theme is the major influence on smartness and is driving the decision process. There is also a hierarchy within each of the three categories (Human Capital, Living, and Environment), identified above as specifically contributing to liveability, where their indicators are assessed within their own categories, i.e. to give priority to indicators in each of these categories, and this shows the level of importance of these categories in developing the smart city vision. A pairwise comparison might prove beneficial for the next steps of the tool development. At the initial steps of an assessment tool in this research, this tool suffers from there being no list of criteria for liveability, and a fundamental adaptation would be required.

3.2.1.2 Smart City Wheel

In 2013, Cohen introduced the Smart City Wheel (Figure 3.3), which was considered an advancement of the smart cities assessment (particularly in comparison to the ANP network model) since it provided a self-explanatory set of smart assessment actions and indicators, equally divided into six different categories of smartness (Cohen, 2013), as shown in Figure 3.3. The six categories of Cohen's Smart City Wheel (Environment, Economy, People, Living, Mobility, and Government) are graphically represented at the core of the wheel and the related actions and indicators can be found at the outer edges. As seen in Figure 3.3, each of the categories relates to a subcategory of three 'Actions & Indicators'. However, Cohen (2015) developed the smart city categories and, here, the 'Actions & Indicators' are shown as 'Criteria' (Table 3.2) and are in some cases slightly changed. For example, in the Smart Mobility category, one of the Actions is 'Integrated ICT', whereas in the table, it is shown as Technology Infrastructure. However, these differences do not affect the main smart city categories. Some of Cohen's indicators (16) are designed to comply with the International Standardisation Organisation (ISO) standard for sustainable development (ISO 37120), which is encouraging in terms of this thesis' argument, and especially in two of the six criteria (smart human capital and smart living) put at the centre of its argument. However, the list of indicators is difficult to read: some of them measure the percentage of people with smartphones; engagement with creative business; and Mercer –an international commercial company that produces rankings on living quality-surveys

(Cohen 2014; ISO 2014). Moreover, the original approach to developing the Smart Wheel involved identifying approximately 400 indicators, which was later on reduced (from 62 to 45); the reduction in the indicators' list shows a loss of its potency for a holistic liveability assessment. Additionally, the categorisation of 'smart' is unclear for two reasons: it is not well defined what 'smart' describes and what the dependency is between these six categories. Also, the absence of any clear numerical measurement suggests that there is subjectivity to the performance of the assessment and perhaps a lack of application or transferability.

It is possible that liveability parameters exist within the categories and that further description of the 'Actions & Indicators' would provide more clarity. For example, within the wheel (Figure 3.3), the 'Smart Environment' segment includes three indicators: 'Smart Buildings, Resource Management, & Urban Planning'; in 'Smart Living' there is 'Health, Safety, & Culture and Happiness'; 'Clean and Non-Motorised Mobility' is listed in 'Smart Mobility'; 'Open Government' appears in 'Smart Government'; and finally, in 'Smart People', there is 'Education, Inclusive Society, & Creativity'. These dimensions could become the basis to develop liveability indicators, based on their social approach and potentially could be used to assess the smartness of a city and are described in the next section.

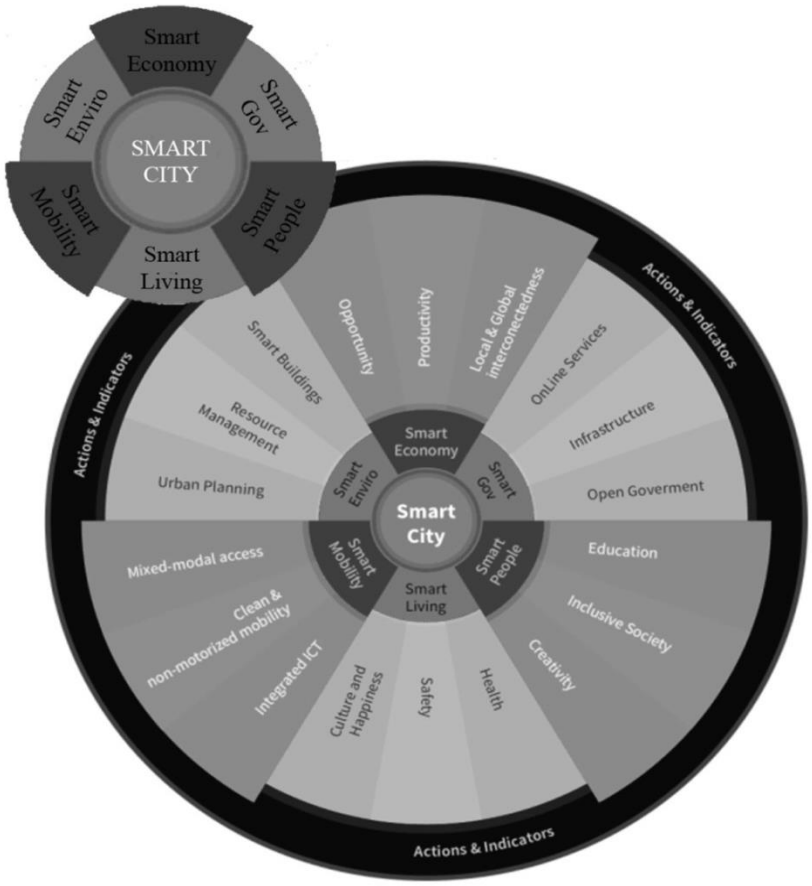

Figure 3.3: Smart city wheel and inner wheel detail with Smart city categories, adapted from Cohen (2013)

The initial indicators representing the 'Actions & Indicators' in the Smart Wheel reached a total number of 400; this was later refined to a list of 62 indicators, and then reduced to only 45 for clarity by the author (Cohen, 2013). The 45 indicators shown in Table 3.2 aim to cover each category of the Smart Wheel – i.e. each smart category is evaluated using these indicators and, based on this assessment, a city can judge whether a category is well developed or in need of further action. Each of the categories that potentially contain liveability criteria, show indicators that are able to measure liveability in some way: the effects of climate change in the built environment and the sustainable planning of it (Smart Environment), public participation in implementing technology and education (Smart People) and personal liveability in terms of health, safety, local and global connectivity (Smart Living).

Table 3.2: Smart City Indicators (adapted, Cohen, 2015)

Category	Working area (Criteria)	Indicator
Smart Environment	Smart Buildings	Sustainability-certified buildings Smart homes
	Resource Management	Energy Carbon footprint Air quality Waste generation Water consumption
	Sustainable Urban Planning	Climate resilience planning Density Green space per capita
Smart Mobility	Efficient Transport	Clean-energy transport
	Multi-Modal Access	Public transport
	Technology Infrastructure	Smart cards Access to real-time information
Smart Government	Online Services	Online procedures Electronic benefits payments
	Infrastructure	Wi-Fi coverage Broadband coverage Sensor coverage Integrated health and safety operations
	Open Government	Open data Open apps Privacy
Smart Economy	Entrepreneurship & Innovation	New start-ups R + D Employment levels Innovation
	Productivity	GRP per capita
	Local and Global Connection	Exports International events held
Smart People	Inclusion	Internet-connected households Smart phone penetration Civic engagement
	Education	Secondary education University graduates
	Creativity	Foreign-born immigrants Urban Living Lab Creative industry jobs
Smart Living	Culture and Wellbeing	Life conditions Gini Index Quality of life ranking Investment in culture
	Safety	Crime Smart crime prevention
	Health	Single health history

It is not yet clear if such a general index of indicators provides sufficient evidence of whether a city is smart or not, particularly because of the decision to reduce the number of indicators. That said it is a start on the right road to addressing liveability in smart cities, as some indicators show the plethora of elements that contribute to the liveability of a smart city; for example Smart Environment and Smart Living. For these reasons, the Smart Wheel has a level of ambiguity about it when it comes to assessing truly smart cities. The Smart City Wheel, therefore, provides the closest fit to address the requirements of this thesis, other than CityLIFE (see Section 3.9), but it fails to provide the level of detail required of a holistic set of liveability criteria for truly smart cities.

3.2.1.3 Academic Tools Conclusion

The two assessment tools designed by academics recognise either five (Smart City Network Model SCNM) or six (Smart Wheel) categories as the basis of a method for assessing a smart city. These categories include a list of indicators that are associated with each smart category. In both cases, there is evidence of assessing smartness through liveability criteria; for example, both tools assess living and environmental indicators, as well as 'People' (in the SCNM, it is named 'Human Capital'). However, both of these tools developed by academics, followed a smart category approach which does not fit the wider approach adopted in this research.

3.2.2 Commercial

Smartness captured the attention of telecommunication and digital services offered by big commercial companies before the subject itself gained academic and individual cities' interest. This section explores the assessment tools developed by three commercial organisations: IBM, as one of the first and largest international organisations to lead smartness; Urban Tide, who are UK-based consultants; and collaboration between a digital provider (Porism Delivery Ltd) which developed the European Service Delivery ESD toolkit along with a UK local government (Porism, 2017).

3.2.2.1 IBM

IBM, as a member of the commercial sector, was one of the earliest to identify and quantify smartness using seven key categories: City Services, Citizens, Business, Transport, Communication, Water and Energy (Dirks *et al*., 2009). IBM's system of comparing the score of a city (using a scale of 0-10) to

that of a Peer City average and Peer City best practice (as shown in Figure 3.4) identifies its potential to grow (Dirks *et al*., 2009). The seven assessment categories evaluate the city's performance and, although the thematic approach could reflect issues of liveability, it is clear that this is a 'service approach' for smart cities. As Figure 3.4 implies, the categories used in the assessment could potentially be used in the future to explore liveability if the indicators or performance parameters used to create each score were defined specifically with liveability in mind; however, there is no indication of the indicators used in each category, hence no direct link to liveability can be assumed.

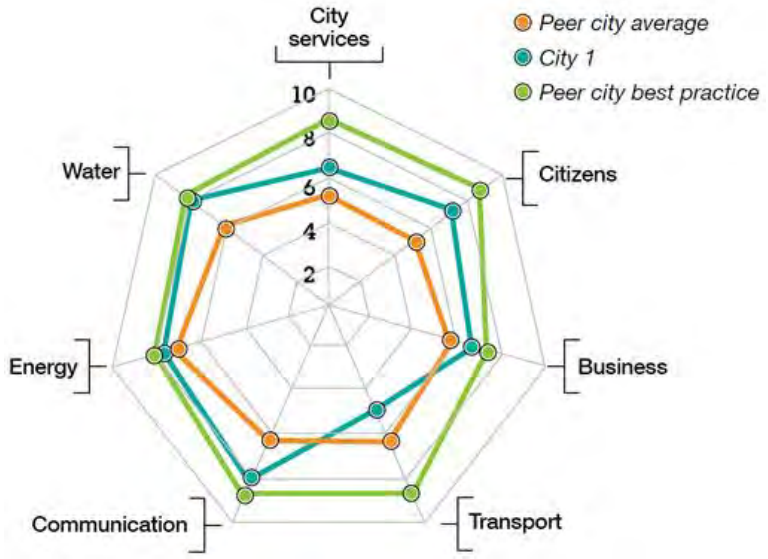

Figure 3.4: Example scoring of the IBM assessment tool (Dirks *et al.,* 2009)

Of its seven categories, liveability could be addressed in some manner under the 'Citizen' category, and perhaps partially under other categories. That is to say, whilst this looks like a useful thematic approach (not in smart categories similar to the Smart City Wheel), further explanation is needed to establish liveability. Additionally, it is not shown how the group of seven categories emerged, and whether there is a connection between them; for example, what is meant by 'City services' when categories such as 'Water' and 'Energy' are also included in the categories? In general, the tool and smart indicators are only accessible in terms of business service provision – the system as a whole is not accessible to the wider public, or even to the research community (IBM, 2015).

It is instantly evident that IBM's Assessment Tool is not an open-access tool and one can only assume what each category represents (Dirks *et al*., 2009). This goes against the whole ethos of a liveable smart cities assessment tool, which should be both transparent and accessible. For this reason, this tool is not considered one that is able to assess truly smart cities. The tool provides no information (at least at this stage of accessibility) that shows how these are measured and compared against the model smart city; thus, such a comparison does not show a connection to contextual information (such as local systems, local resources, or geography). Mainly because it is not possible to access the tool, as it is only accessible in business terms, this tool can be discounted.

3.2.2.2 Urban Tide

Urban Tide is a smart cities consultancy, one of the first to assess smartness as a liveable solution, and one that aims to find ways to engage cities in the idea of 'smart' using data from a living and business-profiting point of view. It considers both digital and human aspects of smart cities as overarching principles in their collaboration on the OPEN Glasgow project (GCC, 2014; Urban Tide, 2016). The systematic vision of this dual approach is translated through twelve domains and adopts the five-stepped process shown in Figure 3.5. Each domain is explored through its 'Strategic Intent', 'Data & ICT', 'Tech & Innovation', 'Service Delivery' and 'City Wide Engagement'. However, there is no specific smart city category that the twelve domains belong to, and not much indication that either the twelve domains or the five steps are indeed considered to be indicators used to assess smartness. Therefore, it is difficult to say if this is explicitly smart or which part of the smart assessment is liveable.

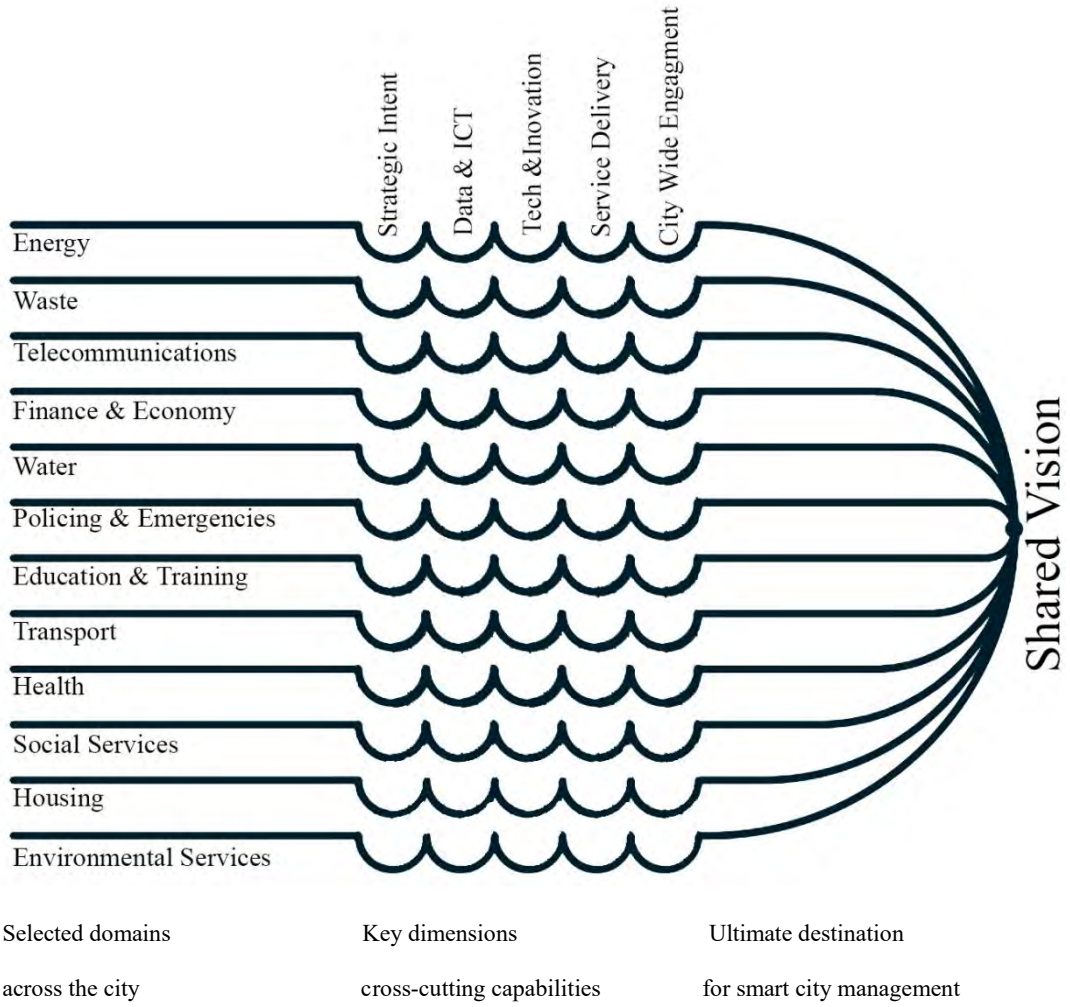

Figure 3.5: Cities' assessment, adapted from Urban Tide (Urban Tide, 2014, p25)

On a superficial level, it is difficult to explore whether the focus of the relationships relates to smart city capabilities. Later on, Urban Tide's efforts to assess smart cities were applied to an expanded dataset, which included some of the domains of the earlier assessment, as shown in the second column of Table 3.3 (Urban Tide, 2016). Here, it is evident that some domains are omitted (Waste, Education & Training, Policing & Emergencies), while new ones are introduced, and the shared vision has been heavily influenced by a few of these domains.

Table 3.3: Urban Tide dataset domains, adapted from Urban Tide (2016)

Domains dataset	In shared vision	Number of datasets
Health	x	146
Housing and Zoning	x	124
Government and Public Sector	x	101
Geospatial		78
Built Environment		71
Social Community		69
Energy	x	40
Natural Environment	x	21
Infrastructure		19
Transport/Mobility	x	13
Economic	x	11
Water	x	10
Innovation		5
Logistics		4
Communications	x	3
Technology		1

The domains in Figure 3.5 become thematic datasets, as shown in Table 3.3 and are collected mainly from open datasets shared by city councils – for example Peterborough City Council, Edinburgh City Council, Glasgow City Council, Belfast City Council, North Lanarkshire Council, Sheffield City Council, and even Birmingham City Council – along with organisations that share some of their data (for example, NHS Western Isles, Data Mill North Leeds/Bradford, Crichton Institute Regional Observatory) (Urban Tide, 2017). Although this example gives an initial idea of how services could be connected to the intentions of smart cities, the domain datasets do not describe their meaning or, furthermore, how liveability is perceived in smartness beyond the controlled services in a smart city.

The Urban Tide Shared Vision (Gardren *et al*., 2014, and Urban Tide, 2016) is founded on a large collection of datasets that are organised into 16 domains of the shared vision, aligning to city sectors and city competencies. The combined dataset (open-gathered from local councils and organisations) has been developed by Urban Tide using most, but not all, of these categories and therefore falls short of a comprehensive assessment base for the 12 categories of the listed shared vision, quite apart from failing to cover the wider issues necessary to assess liveability. Although that example gives a first idea of how services could be connected to the intentions of smart cities, the different categories of such tools do not describe the meaning and how liveability is perceived in the context of smart,

further than the controlled categories of services in a smart city. For this reason, at this stage, these datasets can be perceived as an optimisation of service provision. The open datasets do not provide adequate evidence (i.e. coverage) of liveable datasets for smart cities for the reasons stated above, and datasets on their own cannot be considered as a useable assessment method. Surely, the data domains do not provide a useful way to assess the smart initiatives of a city.

Although Urban Tide was initially a tool for assessing smart cities perceived as being founded on a shared vision, however it falls short as it becomes a dataset of existing data offered by organisations and this cannot practically assess smart initiatives. Furthermore, there is no evident description of what can be considered liveable, for true smartness.

3.2.2.3 European Service Delivery ESD

Porism Limited is a software company who, in collaboration with UK local government, produced the Smart Cities Regional Academic Network (SCRAN) methodology to develop the European Service Delivery (ESD) toolkit, which portrays participants in smart cities as the consumer within the remit of local governance (Thacker, 2009). Figure 3.6 shows the commercial approach adopted in the local governance system, which sees city operations as commercial services and the customer as a smart city actor who can be targeted according to location, employment status, and susceptibility in terms of data security (Thacker, 2009).

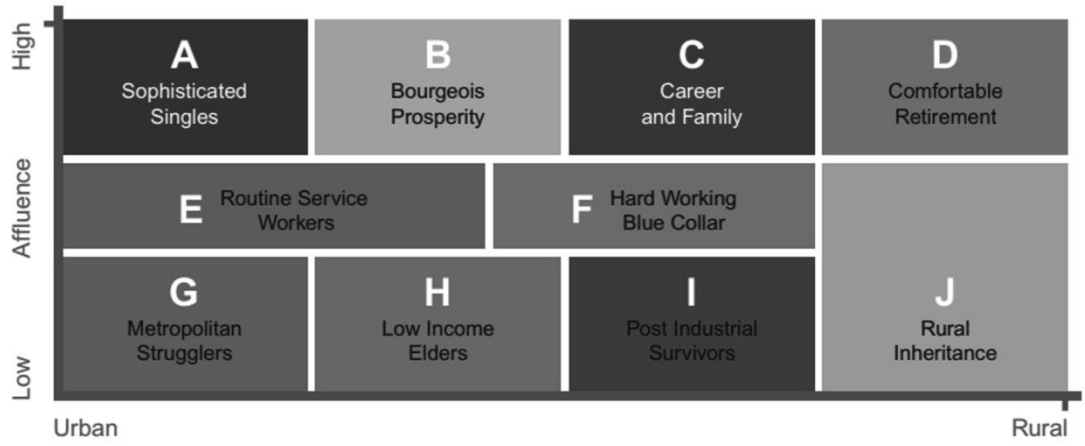

Figure 3.6: Profile groups in the European Service Delivery (ESD) toolkit (Thacker, 2009)

This service delivery model can enhance collaborations between the commercial and governance sectors, and view smart cities through the same collaboration (here, the North Sea Region Programme of the European Union) as smartness shifts to a digital metrics system that can analyse citizens' use and provision of services in local contexts (Soom, 2009). A focus of the activity is services in connection with household location and affluence (shown A-J in Figure 3.6, with categories ranging from Low to High and Urban to Rural). Each of the categories in Figure 3.6 indicates the required service as an index of the demands related to an area based on population demographics and distribution; this can dictate the importance of required service provisions for the specific area, as well as the impact of the service (Thacker, 2009). Thacker summarises the approach as: ESD evaluates citizens as consumers in order to estimate the service demand according to their characteristics and make future predictions of service demands by anticipating future demographic changes. Perhaps examining the collaborating parties in more detail would lead to a less passive service approach and a more positive attempt to engender liveability. Indeed, for this reason, some collaborative tools seek to achieve exactly that. However, it is not possible to consider this approach as having categories and indicators that relate to (true) smartness or even to claim that it aims to enhance the liveability of cities. A solely 'service approach' to smartness (i.e. where the goal is simply efficiency) is consequently considered as lying outside the remit of this research and, for this reason, the ESD method is not considered as adding any further value to this thesis.

From the initial description of the European Service Delivery (ESD) tool; it was evident that it had serious limitations when addressing the hypothesis of this research. The ESD tool adopts a commercial approach to the governance of smart cities and considers a 'service approach' for citizens, who are categorised into ten citizen types, divided into a three-rating arrangement. The categorisation shows areas in which public data are collected, but does not provide a linkage to citizen liveability. Similarly, there no indication to how the ESD would support democratic procedures, meaning how it could be used by others; furthermore, what the wider conceptualisation of assessing true smartness. Although this categorisation might prove beneficial for local governance service provision, the basis

of smart visioning and the role of liveability are compromised and for these reasons, ESD does not fit the research focus of this thesis.

3.2.3 Governance (Including Academic Collaboration)

Often, the collaboration between sectors can prove beneficial, as it can explore elements beyond only commercial service provision. Because of such collaborations, the tools become more complex in the organisation and execution of an assessment. In this section, two main tools (ASCIMER and CITYkeys) are explored.

3.2.3.1 ASCIMER

'Assessing Smart City Initiatives for the Mediterranean Region' (ASCIMER) is a sophisticated tool arising from the collaboration of academics and governance (Mediterranean Municipalities) and funded by the European Investment Bank-EIB. It is used to assessing smart city initiatives in the Mediterranean Region (Romera *et al*., 2017).

This tool aims to assess the quality of urban living (within the smart vision) in the Southeast Mediterranean according to the following categories: Governance, Economy, Mobility, Environment, People and Living, these categories being identical to those of the Smart Wheel (Monzon, 2015). Similar to the Smart Wheel, the categories can be considered as enhancing the liveability focus on data collection for sustainable planning and infrastructure (Environment), participation through initiatives (People), skills (Economy) and digital services for improving the quality (not simply the efficiency) of services for citizens (Monzon, 2015). As Figure 3.7 shows, the six categories overlap each other, with the word 'smart' in the middle. A fine-line circle represents ICT to indicate that each category is connected as a digital system. Two outer rings of elements, designed only for the Southeast (SEM) and North (NM) Mediterranean areas, represent the challenges associated with the main six categories of smart in a series of coloured inner rings (SEM) and grey outer rings (NM). There are some connections between the categories in the middle and the outer rings of challenges, to represent shared issues.

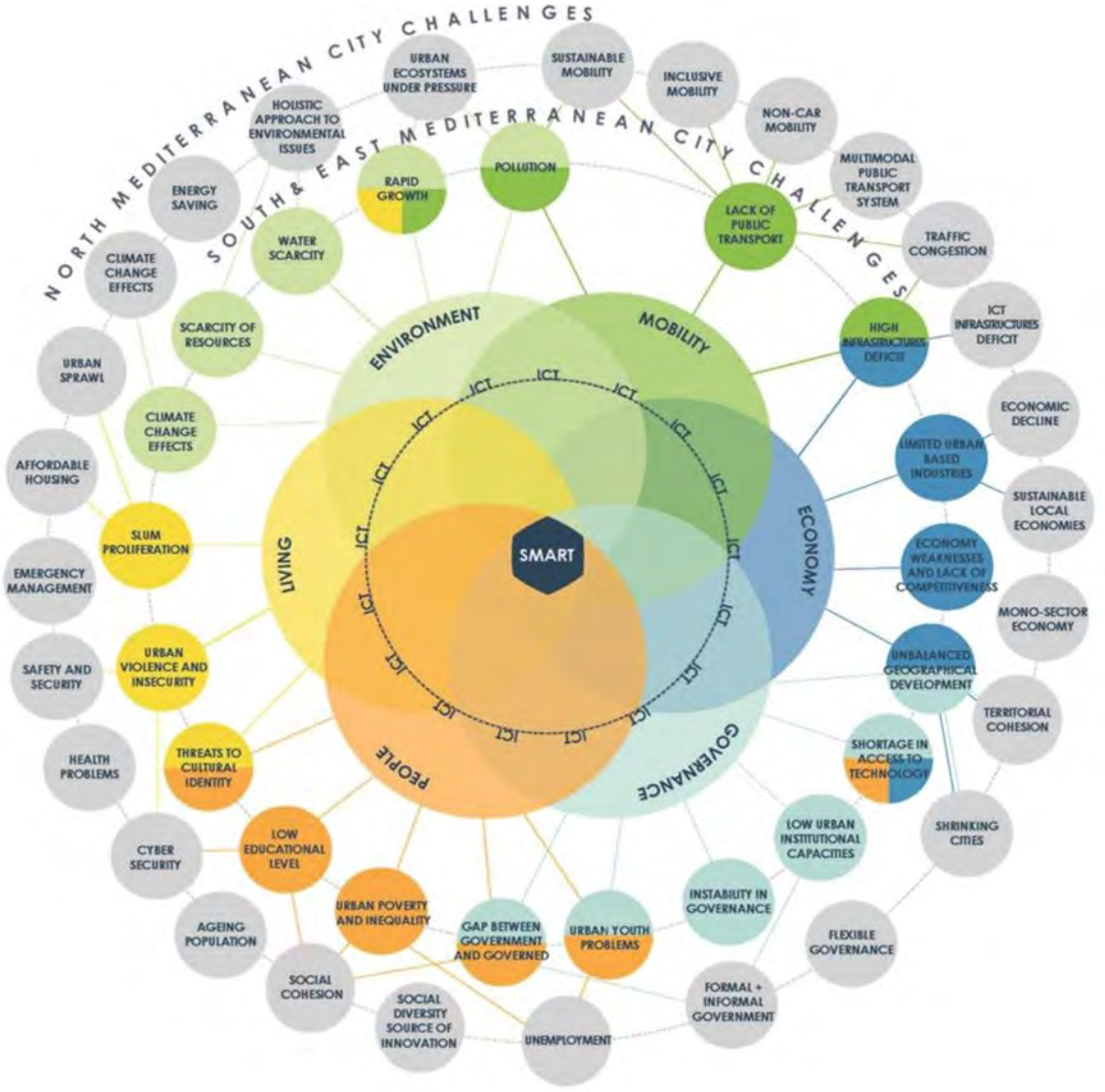

Figure 3.7: Challenge categories for the Southeast and North Mediterranean (Monzon, 2015)

As Table 3.4 shows, each smart category lists a number of actions as 'Project Actions', to address the challenges faced in Mediterranean cities. There is a broad consideration of liveability in the categories (notably Environment, People and Living), which include Project Actions on resources, planning, skills and digital inclusivity (Smart Environment and Smart People), while the Smart Living category includes health, safety, culture and tourism. The Project Actions listed under Smart Governance and Smart Economy could also claim to consider elements of the wider liveability agenda, for example, participation and interconnectedness; however, in these actions, the elements are mainly focussed on governance service provision and market strengths, and in this respect (and without greater detail), do not fit entirely within the scope of liveability as viewed in this thesis. Smart

Mobility, likewise, has elements that address the liveability agenda (e.g. accessibility; clean, non-motorised options).

Table 3.4: Project Actions for ASCIMER Smart Categories (Romera *et al*., 2017).

	Smart Governance	**Smart Economy**	**Smart Mobility**	**Smart Environment**	**Smart People**	**Smart Living**
1	Participation (SGo1)	Innovation (SEc1)	Traffic management (SMo1)	Network and environmental monitoring (SEn1)	Digital education (SPe1)	Tourism (SLn1)
2	Transparency & information accessibility (SGo2)	Entrepreneur-ship (Sec2)	Public Transport (SMo2)	Energy efficiency (SEn2)	Creativity (SPe1)	Culture & Leisure (SLn2)
3	Public and Social Services (SGo3)	Local & Global interconnected -ness (Sec3)	ICT Infrastructure (SMo3)	Urban planning & urban refurbishment (SEn3)	ICT - Enabled working (SPe1)	Healthcare (SLn3)
4	Multi-level governance (SGo4)	Productivity (Sec4)	Logistics (SMo4)	Smart buildings & building renovation (SEn4)	Community building & urban life management (SPe1)	Security (SLn4)
5		Flexibility of labour market (Sec5)	Accessibility (SMo5)	Resources management (SEn5)	Inclusive society (SPe1)	Technology Accessibility (SLn5)
6			Clean, non-motorised options (SMo6)	Environmental protection (SEn6)		Welfare & Social inclusion (SLn6)
7			Multi-modality (SMo7)			Public space management (SLn7)

Figure 3.8 shows an example of ASCIMER's Project Action Matrix (PAM), in which the 'Project Actions' are listed against Challenge Assessment criteria. The PAM can be used to assess the various steps of a smart city project, connecting challenges with proposed smart project actions (Monzon, 2015). Under each category (for example Smart Economy), the Project Actions are shown using the symbols listed in Table 3.4 (SEc1, SEc2, etc.) and are assigned a numerical value for each of the Challenge Assessment criteria. These numerical values emerge from a discourse between members of the local government and experts from local organisations and institutions (Romera *et al*., 2017). Summing the numerical scores provides a general score for each of the dimensions. Depending on the priority level of the local government and the overall score of a project, a decision can be made on the

possibility of advancing areas that an existing city has not embraced or the potential to respond to existing local challenges by implementing smart city projects (Romera *et al*., 2017). For the purposes of this research, it is interesting to see the relationships with liveability and to consider whether there is a possibility to develop a rating system for liveability projects.

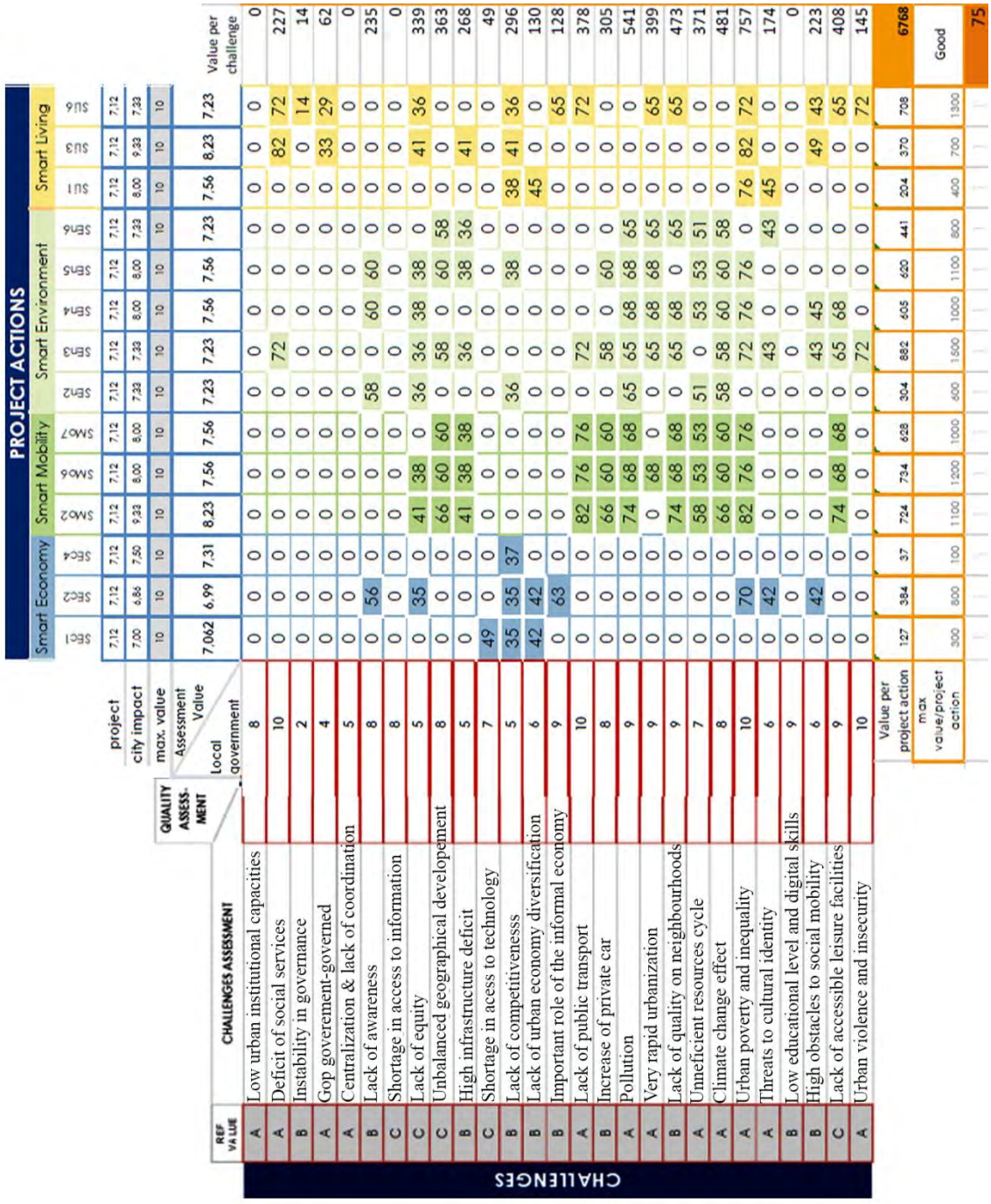

Figure 3.8: Smart City Project Assessment Matrix PAM based on ASCIMER (Romera *et al*., 2017)

The PAM, offers the opportunity to analyse various aspects of smart city projects and provide evidence for a smart city assessment. Therefore, the tool would require expert users to explain or use, contrary to the usability criterion set at the start of this chapter. This is because the detailed evaluation required of the 'challenges and project actions', which gives an overall numerical assessment score provides a means of assessing smart initiatives. Yet this is strongly influenced by the participation of the individuals involved in the discourse; depending on the perspectives those individuals bring, this could either compromise (e.g. by introducing commercial partiality) or enhance (e.g. by introducing a form of citizen participation) the liveability aspects of this approach to delivering smartness. The complexity presented here represents an advanced thinking process for explaining the workings of a smart city and, furthermore, ASCIMER offers an aggregate score, which could provide the basis for an evaluation of smart cities and a ranking based on the total score. Assessing Smart City Initiatives for the Mediterranean Region (ASCIMER: Romera *et al*., 2017) adopts the same categories as the Smart Wheel (Governance, Economy, Mobility, Environment, People, and Living) while helpfully acknowledging that these categories are inevitably, to some degree, interdependent and therefore overlap in terms of performance, and hence, indicators. This research only briefly refers to the ESD tool, mainly because, as a service system, it does not place people at the centre of the liveability of smart cities; therefore, it presents limitations with regard to the hypothesis of this thesis. However, it is limited to assessments in the Mediterranean region, and it would need both translations to the UK context and refinement of the indicator sets, which are combined into what is termed 'challenges', for smart cities in order to provide an appropriate method of assessment of liveability.

3.2.3.2 CITYkeys project

Similar to ASCIMER, the CITYkeys project was conceived by Eurocities, part of the EU Horizon 2020 scheme, as a tool that, by assessing projects, created new business ideas and city models by exploiting the collected datasets of information (Bosch *et al.*, 2016). The taxonomy of indicators clustered under five categories was used to rate their significance to a specific project and generate a framework in the form of a circular spider structure, which compared the smart indicators of the

project by assessing them across five categories: People, Planet, Prosperity, Governance and Propagation (this latter term referring to the project's ability to expand (Kontinakis *et al*., 2017).

Here, the five categories superficially offered a new approach to some of the previously adopted categories. Although, Planet (which is similar to the 'Environment' category in previous tools) and Prosperity (similar to Economy), could be argued to be simply an attempt at alliteration. However, this is the first tool to examine the ability of a smart project to scale, or even relate, to other projects (via the 'Propagation' category). As Table 3.5 shows, the 'People' category contains subcategories of health, safety, access to services, education, diversity and social cohesion, and quality of housing and the built environment, thereby taking a holistic view of liveability. In the 'Planet' category, the subcategories are similar to those mentioned in the review of previous tools under the Environment category, focussing, for example, on resources and climate adaptation.

Table 3.5: Categories and Subcategories of Smart City Performance in the CITYkeys Project (CITYKeys, 2016)

Categories	**People**	**Planet**	**Prosperity**	**Governance**	**Propagation**
Sub Categories	Health	Energy & Mitigation	Employment	Organisation	Scalability
	Safety	Materials, Water & Land	Equity	Community Involvement	Replicability
	Access to services	Climate Resilience	Green Economy	Multi-Level Governance	
	Education	Pollution & Waste	Economic Performance		
	Diversity & Social cohesion	Ecosystems	Innovation		
	Quality of housing & the Build Environment		Attractiveness & Competitiveness		

Each of the subcategories can be compared to a list of indicators in an online tool, which is accessible in the form of an online tool demonstration (CityKeys, 2016). Similar to the categories shown for other tools so far, CITYkeys also refers to categories such as 'Education, Climate, Health, Community Involvement, and Governance', all of which could be classed as part of the wider liveability agenda. By using these categories for comparison purposes, it appears that liveability is not explicitly referred to; rather, a comparison is made instead between ICT and each of the subcategories, as shown in the two examples in Figures 3.9 and 3.10.

Each of these two examples uses the subcategories in an enhanced version, meaning more subcategories are explored (using KPIs) and a rating is introduced (0-5 score). These spider diagrams offer the possibility to compare the city performance for two different time periods and understand the development process according to the categories and indicators (CityKeys, 2016). Specifically, Figures 2.12 and 2.13 show the Key performance indicators (KPIs) for the People and Planet categories, where one would consider links to liveability to be strongest. Figure 2.12 shows the KPIs connected to health issues, safety, accessibility, citizen integration, local, and environmental issues, education and culture. In Figure 2.13, the KPIs for Planet deal with energy, carbon emissions, compactness, climate change and behaviour, and resource efficiency. For example, 'Design for a sense of place' achieved 5 which is the best performance for that criterion, i.e. it is the best measure that could be expected, while a score of 0 indicates that it would not pay attention to the parameter at all.

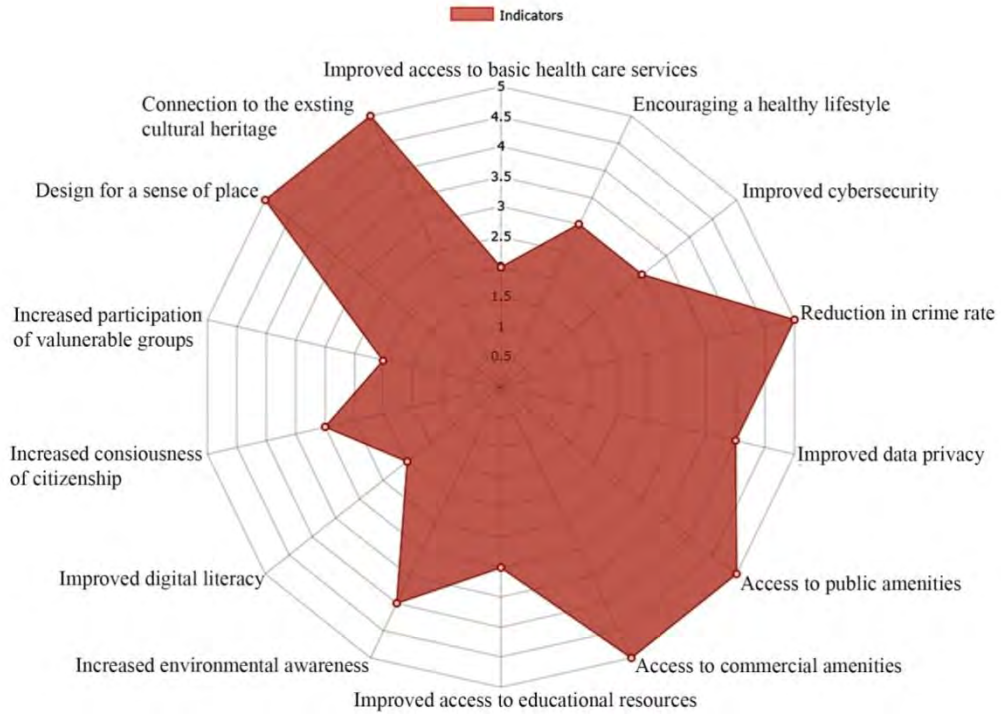

Figure 3.9: City 1-Test Project 1-ICT to People (CITYkeys, 2016)

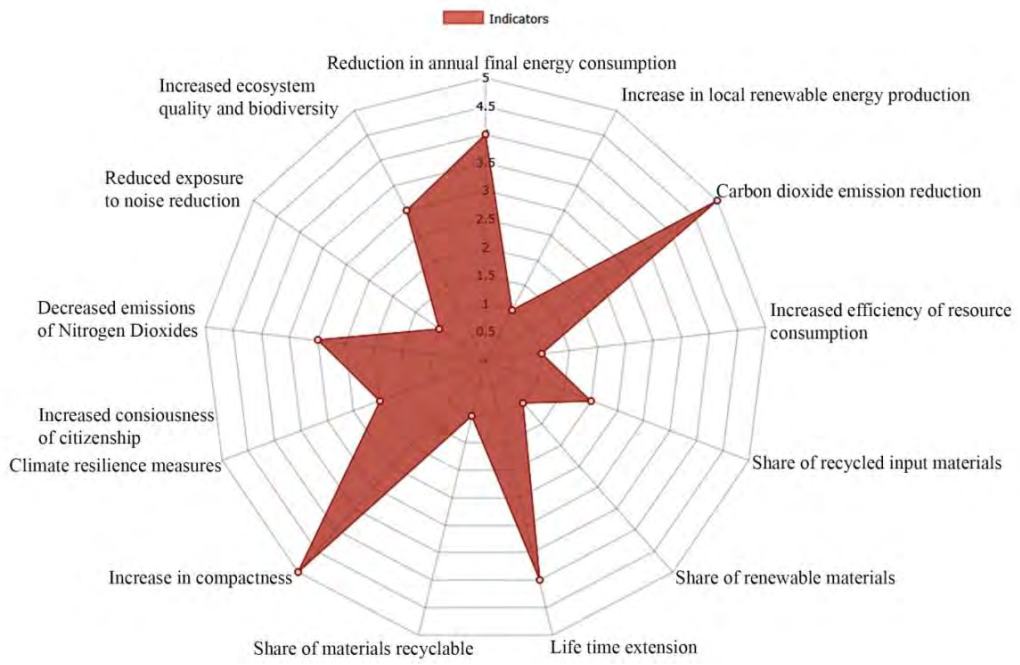

Figure 3.10: City 1-Test Project 1-ICT to Planet (CITYkeys, 2016)

This demonstration tool shows a typical assessment for prospective smart cities based on data availability and area size, and therefore also provides an opportunity to judge the scaling of a smart city project – as noted in the Propagation category (Kontinakis *et al*., 2017). This means that further exploration of KPIs linked to liveability should be explored in relation to their applicability to the CITYkeys assessment tool for assessing the (true) smartness of cities.

The CITYkeys project (Kontinakis *et al*., 2017) is a partially accessible tool that uses indicators to assess projects that relate to liveability (health, education, environment, citizen, culture, and accessibility). Adopting five categories for assessment (People, Planet, Prosperity, Governance, and Propagation), the focus is on projects and their applicability ('propagation' refers to the development potential of the project). Projects are assessed in five spider diagrams according to categories and, by implication, it would be possible to provide a baseline (current city performance), a likely initiative performance and a likely future city performance with the initiative in place. The definition of liveability adopted herein – individual and societal wellbeing and planetary wellbeing – align well to two of the categories, and this approach, if adapted to include the many different indicators that combine to assess the impact on liveability of smart initiatives, would be promising. The ideas and the

approach are therefore useful, but a great deal of work would be needed to establish the correct indicators to use to assess liveability. Another downfall of the tool is that currently is not open access (the examples here are shown in test terms) which makes impossible for others to use it in city assessment

3.2.3.3 EU medium-sized cities

Another interesting collaboration took place in 2007 between academics (Vienna University of Technology, University of Ljubljana and Delft University of Technology) and Asset One, a management company, yielding a ranking of smart cities. (The details were later disseminated to the local governments of interested cities.) This collaboration explored the hierarchies amongst 70 cities, sized between 100,000 and 500,000 people, using six smart city categories – Economy, Governance, Environment, People, Mobility and Living – that were also seen in other tools mentioned in this chapter (Giffinger *et al.*, 2007).

As shown in Table 3.6, the subcategories relate to subjects of innovation, governance, environment, learning, infrastructure, culture, tourism, and education; all of which are common in previously-reviewed approaches and some of which relate or contribute to liveability. However, new ones were also introduced, such as creativity, decision making, international embeddedness, natural conditions, transparency and (more explicitly) social cohesion, to provide balance. Again all can be considered strongly aligned to liveability on a social basis. However, this is another indication that categories used to organise or describe smart city tools, while all interpreted to deliver smartness, conform only to a meaning of smart that is not yet entirely defined and can change according to the aims of a city, its designers and stakeholders. This means that further analysis should take place to explore whether and how these new smart elements can reflect liveability.

Table 3.6: Categories and Subcategories of the Smart City Ranking of EU medium-sized cities (Giffinger *et al.*, 2007)

Smart Economy	**Smart Governance** (Participation)	**Smart Environment** (Natural Resources)	**Smart People** (Social and Human Capital)	**Smart Mobility** (Transport and ICT)	**Smart Living** (Quality of life)
Innovative spirit	Participation in decision-making	Attractiveness of natural conditions	Level of qualification	Local accessibility	Cultural facilities
Entrepreneur-ship	Public and social services	Pollution	Affinity to lifelong learning	Inter-national accessibility	Health conditions
Economic image & trademarks	Transparent governance	Environmental protection	Social and ethnic plurality	Availability of ICT-infrastructure	Individual safety
Productivity	Political strategies & perspectives	Sustainable resource management	Flexibility	Sustainable, innovative & safe transport systems	Housing quality
Flexibility of labour market			Creativity		Education facilities
International embeddedness			Cosmopolitanism Open mindedness		Touristic attractiveness
Ability to transform			Participation in public life		Social cohesion

A collection of city indicators that suit the categories and subcategories of the smart assessment (which emerged from qualitative data from interviews and the available primary data) and available datasets (two thirds local datasets and one third national datasets – for example, from Mercer, Corporate Knights, Anholt, Economist, IW Consult GmbH, University of Mannheim, UMR Espace), shown in Table 3.6, are used to assess medium-sized EU cities (Giffinger *et al*., 2007). In Table 3.7, the five leading cities, i.e. those with the highest rankings, are presented. Here, smart is considered as an operational term used to show cities' capabilities in each of the six categories, with a number showing their ranking in each category (Giffinger *et al*., 2007). Luxembourg is considered the leading smart (medium) city as it has achieved the highest score in the assessment (notably coming first for Economy, second for People, and sixth for Mobility; interestingly, it only obtained a modest score for Environment).

Table 3.7: Ranking of EU medium-sized cities, adapted (Giffinger *et al.*, 2007)

City	Economy	People	Governance	Mobility	Environment	Living	Ranking
LU - Luxembourg	1	2	13	6	25	6	**1**
DK - Aarhus	4	1	6	9	20	12	**2**
FI - Turku	16	8	2	21	11	9	**3**
DK Aalborg	17	4	4	11	26	11	**4**
DK Odense	15	3	5	5	50	17	**5**

The EU Medium-Sized Cities Ranking (Giffinger, 2007) combines rankings across the six smart city categories (Governance, Environment, People, Economy, Mobility, and Living) to enable an overall ranking, which aligns with this thesis' wider scope of the liveability assessment. However, the medium-sized cities considered here are selected according to population size and the availability of data (to assess smartness), and therefore cities with different population sizes or other data available are not included; this is in contrast with this research. The selection of medium-sized cities in Europe recognises the importance of including these in the smart agenda so that they are not overlooked, although a comparison with bigger (or smaller) cities is restricted due to the influences that a different size would have, while the influences of geographical location are not considered (Calderoni *et al.,* 2012). However, the main reason for discounting this method is that this city ranking considers published data as the assessment method and therefore fails to provide the liveability assessment that is being sought in this research; liveability is not explored in a rigorous way that could lead to a deeper understanding of its performance in smart cities.

3.3 Commonality between Categories

The tools discussed in this chapter have adopted a series of different ways to assess smartness in cities. While often using similar categories, they use different indicators and/or methods of assessment, and also apply them to different contexts in terms of location and size. The similarities of the tools indicate that the perception of smartness converges at a high level in terms of the assessment of what is often referred to as categories that link to the criteria or indicators. However, when examining the methods in greater detail, it is evident that assessing the complexity that characterises

smart cities is a task that produces further uncertainty, i.e. uncertainty that goes beyond the difficulty of defining the term 'smart' (Cavada *et al*., 2014). The reason almost certainly lies in the motivation of the individual or organisation for assessing smartness. In order to test the hypothesis presented in Chapter 1, this research explores smartness in terms of liveability, which itself potentially introduces another level of complexity in the assessment of smart, as some elements (categories and indicators) can be considered to cover liveability by implication. However, the primary conclusion from the review of all of the methods detailed above is that there is not a common thread of liveability running consistently throughout the methods: it appears to a greater or lesser degree, yet without coherence.

Table 3.8 shows the commonalities of the categories used in the tools analysed in this chapter. The categories have been grouped according to similar meaning, for example, Economy aligns with Finance, Business and Prosperity. Although, in some cases, the alignment is weak (Communication is aligned with Governance, for example) or broad (Environmental covering all aspects of Resources and Waste). Nevertheless, this shows that all eight tools consider four similar categories in the assessment of smartness: 1) Economy, 2) Environment, 3) Governance and 4) People. Thus, one can understand from the literature that these are the prevailing categories in smartness, even though they might be worded slightly differently in each tool. Three of the assessment criteria (economy, environment, and governance) were discussed in Section 3.1 because they were found to be fundamental in the four smart cities description. The fourth criterion—people—is linked to what this thesis considers as a vital element of the societal aspect of liveability. Beyond the four main categories that are common in all tools, the others vary in terms of their definitions, as shown in Table 3.8.

Table 3.8: Collected categories of smart cities tools

Tool(s) / Categories	Cohen	Lombardi	IBM	Urban Tide	CITYkeys	ASCIMER	EU med-size cities
Economy / Finance / Business / Prosperity	✓	✓	✓	✓	✓	✓	✓
Environment / Planet / Resources (including waste)	✓	✓	✓	✓	✓	✓	✓
Governance / Government (including communication)	✓	✓	✓	✓	✓	✓	✓
Mobility / Transport	✓	-	✓	✓	-	✓	✓
Society / People / Citizens	✓	✓	✓	✓	✓	✓	✓
Living / Health / City service	✓	✓	✓	✓	-	✓	✓
Propagation	-	-	-	-	✓	-	-

As shown by the review of the tools shown in this chapter, liveability in smart cities is often seen sporadically, via elements that are assumed liveable in their execution – for example, living conditions, citizen participation, health issues, and climate adaptation – yet which are not explicit in the assessment. Because the categories, and criteria and indicators, vary between tools, there is no agreement on the parts that can assess how liveable a smart city is: the various methodologies focus on the smartness of cities rather than liveability, yet this simply raises the question of what the purpose of smartness is. For this reason, this thesis recognises the need for an explicit assessment of liveability in smart city assessment criteria.

3.4 CityLIFE

Created as part of the Liveable Cities project, the UK CityLIFE tool is a '*comprehensive tool for holistically*' evaluating the liveability of UK cities (Leach *et al.*, 2017c). Three main aspects are considered to combine in defining liveability: '*human and societal wellbeing, resource security and efficiency, and planetary wellbeing*'. This latter aspect using a proxy of carbon emissions, where relevant. The tool assesses liveability in any specific city (for example, Birmingham; Leach *et al.*, 2017c) using 346 '*indicators*' (or 'performance parameters') deriving from the City Assessment Methodology (CAM) shown in Figure 3.11 (Leach *et al.*, 2017b).

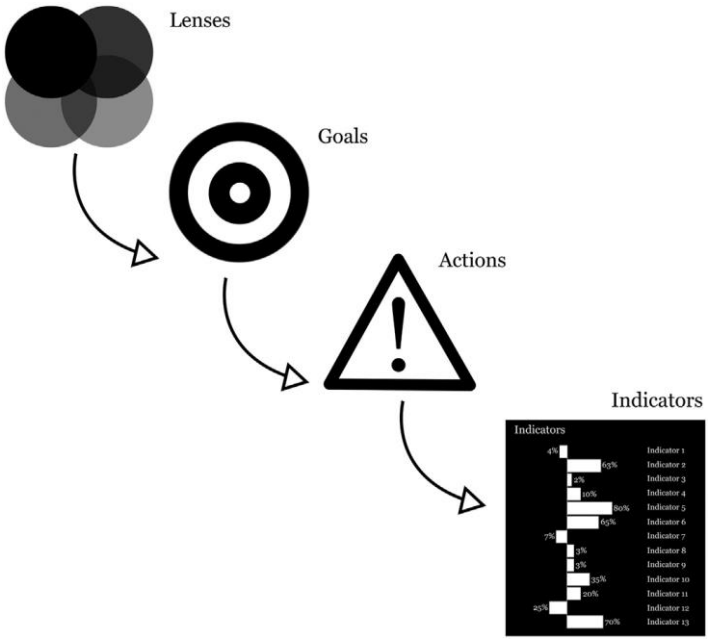

Figure 3.11: CAM for CityLIFE tool assessing Liveability (Leach *et al.*, 2017b).

CityLIFE provides a new means of assessment of the liveability of cities. Since it can be used to assess the likely outcome of any type of intervention – a policy, a practice, a new artefact (such as a piece of infrastructure), it can be used to assess the initiatives adopted by cities in an attempt to become smarter; yet, crucially, assesses smartness in terms of liveability and therefore provides a means of testing the main hypothesis of this research. Across the three-core spectrum (human and societal wellbeing, resource security and efficiency, and planetary wellbeing), CityLIFE can assess whether cities are truly smart (i.e. liveable). This assessment is supported by the four commonly adopted categories (pillars) of sustainability – Society, Environment, Economy, and Governance – to provide a baseline performance framework of liveability in cities and a means of assessing where the impacts of (smart city) initiatives are made in this framework (Leach *et al*., 2017b). These categories are the four Lenses used in CityLIFE. A list of high-level Goals, where Actions needed to achieve these Goals, is used to map the impact of the smart initiatives adopted by a city (and in the case of this thesis, for the four case studies) to show which Goals and Actions are supported and, most importantly, where a Goal/Action is not be impacted at all, showing whether smart initiatives are truly smart (liveable).

The tools explored in this thesis do not explicitly assess the liveability of smart cities. CityLIFE is an appropriate method for assessing liveability performance and is used in this thesis to provide a baseline performance onto which improvements (beneficial impacts derived from smart city initiatives) to this baseline performance can be mapped. CityLIFE is applied within this thesis methodology (SMART) to create a transparent and transferable (to other smart cities) liveability assessment of smart cities (i.e. to determine whether they are truly smart), which it does by demonstrating wherein the comprehensive liveability framework the impacts of the interventions in city systems that are brought about by initiatives are made. It is, therefore, an accessible, transparent tool, able to inform a decision-making approach (and, where relevant, be augmented by a Multicriteria Criteria Analysis, MCA, and/or experts' opinions), while also being an approach that could provide solutions tailored to local needs and different time requisites. This satisfies the call for a holistic approach to assessing the initiatives that are claimed to help create smart cities (Cavada *et al*., 2014; 2017).

3.5 Assessment Tools Conclusions

The tools that have been developed to assess smart cities (or sustainability) use similar overarching categories that limit an explicit focus on liveability, and hence do not enable a direct assessment of liveability. The exception is CityLIFE, which set out explicitly to assess liveability rather than smartness; this has also been reviewed briefly here in terms of its potential to assess liveability directly and will be explained in more detail later in the thesis.

Smartness can mean many things and there is not yet a globally accepted view of liveability in its conceptualisation, or even that liveability should be a central point of focus, therefore a rigorous connection between liveability and smartness does not currently exist. However, accepting that cities are essentially of no value if they do not support citizens and provide for civilised life, and then liveability, as defined herein, must be reflected in smartness. Thus, this literature review concludes that a methodology that aims to assess smartness needs to include a rigorous assessment of liveability if it is to determine whether a city is truly smart. In support of this, it presents an appraisal of the tools

in order to arrive at a methodological approach to support the assessment of liveability in truly smart cities.

Each tool was briefly discussed in terms of its potential to be developed to assess liveability in smart cities, its usability, meaning whether it is open and accessible for others, and its potential specifically to be used in the assessment of smart initiatives; these are criteria that have been explored in the literature review (Chapter 2: city themes, city visions, and the four smart city cases). This chapter recognises that a tool is required to support holistic decision making for truly smart cities, i.e. decision making that addresses liveability as a primary element of smartness. Such a tool should be open and useable (i.e. accessible and straightforward to use by all those who need to use it), transparent, repeatable (i.e. providing the same outcome if used by different people), holistic, able to provide a baseline performance assessment, and then able to demonstrate possible improvements to that baseline performance (and be able to demonstrate the likely impact of interventions to city systems that are brought about by initiatives). [Likely impacts are the impacts that the smart initiatives would bring during (or after) implementation.] This chapter critically evaluates tools designed to assess smart cities, including SPeAR®, in terms of which is best to assess liveability in smart cities. The tools reviewed are: SPeAR®, Analytic Network Process ANP, Smart City Wheel, Urban Tide, IBM Assessment Tool, Urban Tide, ASCIMER, CITYkeys Project, EU Medium-Sized Cities Ranking, and CityLIFE.

The critical review of the smart city tools provides a deeper understanding of the assessment tools available for smart cities (including, for example, SPeAR®, assessing sustainability, and CityLIFE, assessing liveability). However, the analysis demonstrates that SPeAR® is most appropriate for assessing individual projects rather than cities – a basic requirement for this thesis. Furthermore, six of the smart city tools explored use a thematic categorisation of criteria. Although liveability elements are evident among descriptions of the criteria, these smart city assessment tools do not provide a clear liveability context, i.e. one able to assess whether a city is truly smart. For this reason, this research has used CityLIFE to develop a methodology for assessing truly smart cities, as described in Chapter 4.

CHAPTER 4: METHODOLOGY

4.1 Background

Truly smart cities have not been explored and assessed explicitly, as shown in the current literature. Notably, this omission has been shown through a review of the meaning of smart, four smart city exemplars and a critical analysis of the existing assessment tools. They all sporadically refer to notions of living quality or liveability, yet do not explicitly evaluate the delivery of liveability in smart cities, and in most cases, must be adapted to assess liveability specifically. Accordingly, the critical analysis, in Chapter 3, of the relevant smart tools, each of which was briefly discussed in terms of its potential to be developed to assess liveability, established that the CityLIFE tool, which was developed specifically to explore liveability in detail (Leach *et al*., 2016), is most appropriate for adaptation to meet the purpose of assessing 'true smartness' for this research. Chapter 4 develops a method to assess liveability in the context of smart cities – SMART (Smart Model Assessment Resilient Tool) – and more specifically, in relation to the initiatives that have been adopted to make cities smart, which are described in this chapter and also in the Appendices.

4.2 Decision Making For Holistic Thinking

Decision making, both in terms of inspiration and practicality, is an important part of human existence, and both aspects (i.e. aspirational and practical) should be part of city decision-making. In the context of this thesis, it is essential to perceive smart as a complete entity, where all liveable aspects are just as important as functional aspects and need to be better understood in order for liveability to function, and to be maintained, in smart cities (Melvin, 2012). A city decision-making process should be carefully designed to analyse and, where possible, evaluate the context, and any proposed activity when considering a 'decision for a liveable outcome'. This usually involves a sequence of choices over time that lead to a judgement on which initiatives would result in a truly smart city (Roebuck, 2011). This process is explored in a two-strand methodology of smart city initiatives and experts' opinions, in a similar manner to that used in a Hong Kong planning regeneration scheme, where three core aspects – economic, societal and the physical mode of

development – were analysed (Shen, *et al,* 2014). This is an example to show that previously more than one aspect in the analysis was used to evaluate urban planning.

Professionals take part in the process of engaging in a discourse and practice conceptual thinking, perhaps also applying forecasting methods, in an attempt to reach a consensus in the decision-making process (Adair, 1985). As discussed later on in this chapter, the tool (SMART) is required to support the group of stakeholders taking part in the decision-making process when aiming to achieve liveability in smart cities by providing a transparent and repeatable analysis of proposed initiatives (or interventions in city systems, as described by Rogers, 2018) in the context in which they need to work. The outcomes could be used in a Multi-Criteria Analysis (MCA) model to aid decision making, as shown in Figure 4.1, in order to offer further analysis and prioritise proposed initiatives via discussions, with the help of a facilitator. This involves examining the likely impacts on a city's performance criteria using the SMART and considering, in the group discussion, their connections (i.e. dependencies and interdependencies) until they reach a consensus on how best to achieve true smartness in the city in question. This process is shown in Figure 4.1 (Montibeller and Franco, 2010).

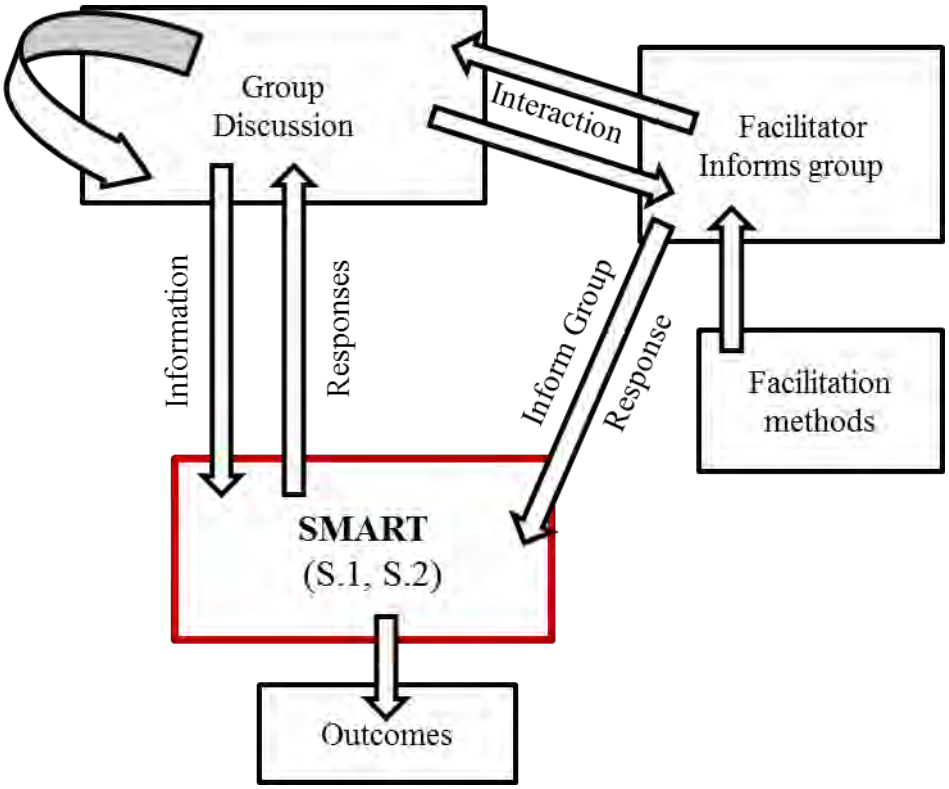

Figure 4.1: Multi-Criteria Analysis MCA Model, adapted from Montibeller and Franco (2010)

Enhancement of the MCA could also include the Dominance Rough Set Approach (DRSA), where criteria appear of greater or lesser importance among others, yielding a gradation of the dominant criteria. Additionally, Cost Benefit Analysis (CBA) and Cost Effective Analysis (CEA) methodologies can be applied as monetary methods when considering the cost of an initiative (i.e. to assess the cost of delivering liveability in smart cities) and its significance for organisations and governance (Greco *et al*., 2002).

In this thesis, a methodology that assesses liveability, organised into categories of smart city initiatives without weightings and their likely persistence into the future as city contexts change, is described. As suggested in this section, the outcomes could later be used in MCA and the Analytical Hierarchy Process (AHP) to establish priorities amongst, and determine the appropriate sequencing of, a set of proposed initiatives that in turn will have derived from a set of policies put forward by those governing the city (Bobylev, 2011); MCA and AHP thus would help to inform decision-making, founded on the evidence base created by SMART, which would result in enhanced liveability in smart cities (Lazaroiu and Roscia, 2012). The group discussion method shown in Figure 4.1 (and additional MCA methodologies) is recommended to be used, but is not part of this thesis. The next section develops a two-strand methodology that supports the liveability assessment of truly smart cities.

4.3 Methodological Structure

This section describes the methodology adopted to test the hypothesis of this thesis and meet the aims and objectives listed in Chapter 1. The tool, SMART, is explained in two strands, in Sections 4.3.1 and 4.3.2.

4.3.1 Strand One (S1)

Strand one is the initial approach to explore the initiatives developed as part of the smart city agenda of a city, see Figure 4.2.

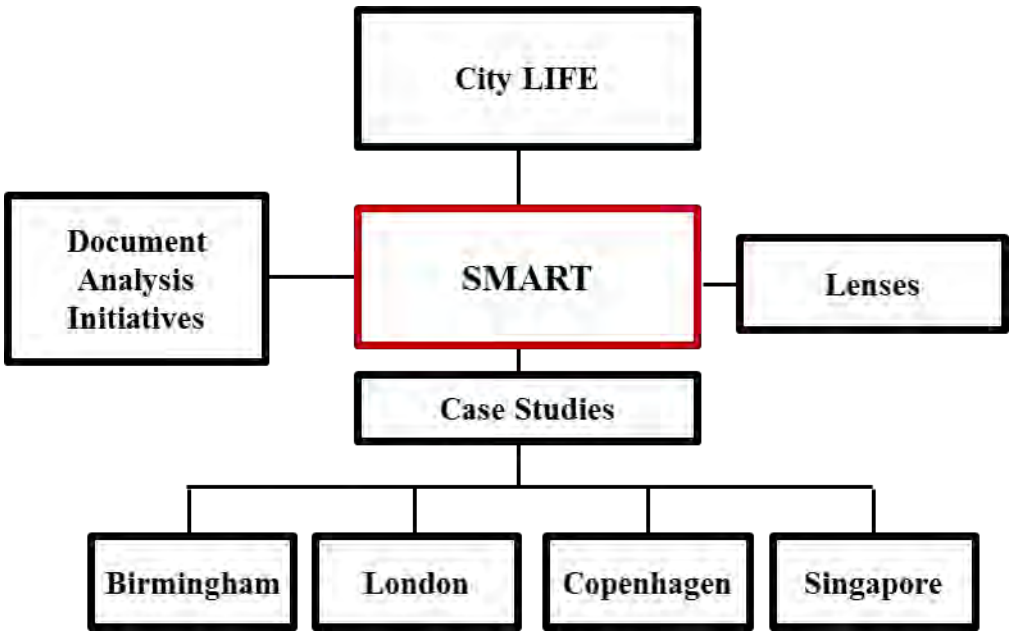

Figure 4.2 Research methodology strand one SI structure

4.3.1.1 CityLIFE

SMART was developed in accordance with the Liveable Cities project to '*transform the engineering of cities to deliver individual and societal wellbeing and planetary wellbeing*' using the CityLIFE methodology for a liveability assessment free from commercial bias (Liveable Cities, 2013; Leach *et al*., 2017b).

4.3.1.2 Document Analysis of Initiatives

Document analysis refers to the initiatives developed and can be found in Appendix A-D. There are two sets of lists ('Initiatives & Initiators' and 'Benefits & Impacts') for each case study city (Birmingham, London, Copenhagen, and Singapore). The Initiatives & Initiators (Appendices A-B-C-D) contains information in six columns:

i. Sequence number
ii. Name of the initiative
iii. Description
iv. Source (web link)
v. Initiators
vi. Reach

In these six categories, the listed initiatives are documented to ensure open direct access to the nature of the initiative and its relevant information. In the documents list, a sequence number is given to each initiative, which can be referenced to documents that follow. The initiative name is assigned as found in the source, as is the name of the initiator. An initiator is the organisation or body that has adopted each initiative. Both the name of the initiative and the initiator are found in the sources. A full quantitative assessment of the initiatives is inappropriate given the time available for this research and the variable quality of the information available about each of the initiatives. Therefore, the last in this list (reach) indicates the time constraint of the initiative; whether the initiative is still active (A), completed (C), or unknown (U); and also gives a qualitative assessment of the scale of its impact. This information enables a baseline assessment of the initiatives of the four case studies. A second set of documentation (Benefits & Impacts) is developed to describe the benefits of each of the initiatives. This is found in Appendices A-B-C-D and lists:

i. Sequence number
ii. Name of the initiative
iii. Aims and intended benefits
iv. Impacts (Direct and Indirect benefits)

This document lists the initiatives with the same sequential numbering and names as shown in both lists. The third column lists the intended benefits of the initiative, as described in each initiative source. In the third column, the impacts of the initiatives are evaluated in terms of their anticipated intended (i.e. direct) and likely indirect benefits, assuming that the implementation of the initiatives proved successful. The Benefits & Impacts documentation (Benefits & Impacts) will be used in the Lens assessment described in S2 and the judgement on direct and indirect benefits is discussed, with an example, in Section 5.1.

4.3.1.3 Lenses

The four Lenses are contained in the CityLIFE methodology that assesses liveability. This uses the Cities Analysis Methodology (CAM), a framework to evaluate city performance through the four

Lenses that inform Goals that lead to policy making Actions (Leach *et al*., 2016). These Lenses are used in this research to assess the four case studies in three steps (Appendices A-B-C-D):

i. Goals and Actions graphically presented in the rows of a table against the smart initiatives (in columns), using the X symbol to show where direct and indirect beneficial impacts occur.

ii. A three-star assessment evaluates the population impact of the initiatives.

iii. Totals of direct/indirect Actions (according to each Action and according to each initiative) are provided.

Implementation of the intended benefits cannot be explicitly predicted, given the change in societal groups and the decision-makers involved, yet those decision-makers (specifically those in senior top-down positions) need to make decisions on the overall agendas or strategy, avoiding influences on the course of initiatives according to partial change (Balogun and Johnson, 2005). Therefore, the clarity of the aim needs to be maintained (as in this research) as a focus on true smartness, deeply rooted in the early conception and implementation of the long-term strategy, as previous research conducted by Sridharan *et al.,* (2007) demonstrated when reporting on a practice based on the strategic purpose of sustainability initiatives and not on a prognostic assessment. Often decision making is based on the interpretation of numerical data, yet on elusive matters like sustainability or ecology, and furthermore true smartness, there is an inherent complication (quantitative data are not uniformly available) allied to the obligation on the decision maker to provide positive benefits—individual, societal, and planetary well-being (Stewart-Oater *et al.,* 1986). Going into too much detail on the assessment criteria would require a change in time, effort and capability of the assessors to reach what Boschma (2005, p12) describes as "*cognitive proximity*", a general knowledge between subject actors, that would offer a higher level of interactions and, thus, potentially more innovative solutions. In addition, subjects such measuring liveability in smartness, which can and has been contested, require measurements to be made against timeframes, to ensure momentum of the solutions is maintained. Research has shown that the deeply rooted meaning of liveability has not been measured in specific terms, although Testa and Simonson (1996) suggested a three-step medical evaluation of liveability:

'prediction, observation, and cost-benefit analysis', which would support priorities for human lives. Whether liveability is explored for individual (patient care) or overall benefit in smart cities, the evaluation process would always be measured in terms of short timescales. For these reasons, complexity in the 'reach' of the impact have been avoided and in this research a three star assessment was adopted – three scales of impact that could be robustly judged and defended.

The three-star assessment (shown in the initiatives' rows) evaluates the degree of impact on the population, or 'reach': one star (*) represents a small group of the city population being affected; two stars (**) are used to represent a larger group (a substantial proportion of the city's population), such as users of digital technology or business sectors; and three stars (***) are used where the impact is expected to, or has the potential to, affect the whole city population.

4.3.1.4 Case Studies (vision and intended benefits)

Four case studies are explored here (Birmingham, London, Copenhagen, and Singapore). Each case study contains a city vision and documentation. The documentation for each case study has been used to explore the initiatives and make an assessment according to the CityLIFE Lenses. Each case study is analysed in Chapter 5. The documentation has been obtained for each city as described below.

In Birmingham, the main initiator of the smart city agenda is Digital Birmingham, which also administered the Smart City Roadmap in Birmingham (DB, 2018b). DB refers to the initiatives as projects and is the main source of Birmingham's initiatives, along with Innovation Birmingham; both were initiated by Birmingham City Council (BCC, 2018).

London's smart plan is also led by the local government, in this case, the Mayor of London's office (MoL, 2018), and some smart initiatives have already been completed (i.e. put in place by the previous Mayor). In addition, the Future Cities Catapult, which is supported by the national government (FCC, 2016), along with Arup's solutions for Smart London (Buscher *et al*., 2016), have provided initiatives.

Interestingly, Copenhagen seems to have extended its smart (and green) collaborations beyond the city, being initiated by and operating beyond the local governance organisation. Specifically, as seen in Appendix C, these are: Copenhagen Solutions Lab, focusing on a 'green and smart laboratory' approach, which is part of the Municipality (CSL, 2009); Copenhagen Health Cluster, working alongside the City of Copenhagen (CC, 2018); State of Green-Copenhagen Climate Plan for 2025 (Bjerregaard *et al.,* 2009), also part of the City of Copenhagen (2014); Smart City Energy Lab – a publicly funded laboratory (ELN, 2018); and IBM's report on Copenhagen's Smarter Cities Challenge, granted by IBM to the city of Copenhagen (IBM, 2013).

Lastly, in Singapore, all initiatives are led by Smart Nation Singapore (SNS), developed by the main government through the Prime Minister's office (SNS, 2017). SNS also supports other agencies, such as GovTech Singapore (2016) and the National Youth Council (NYC, 2016).

4.3.2 Strand Two (S2)

In the second strand (S2) of the methodology (Figure 4.3), the SMART analyses of the initiatives' documents (yielding benefits – direct and indirect) are shown according to the CityLIFE Lenses. However, as explained later, the SMART methodology has been developed to allow for additions. In this thesis, 'Local experts' opinions' (shown on the right-hand side of Figure 4.3), are used to provide this additional input. Similar to S1, each box will be explained in this section.

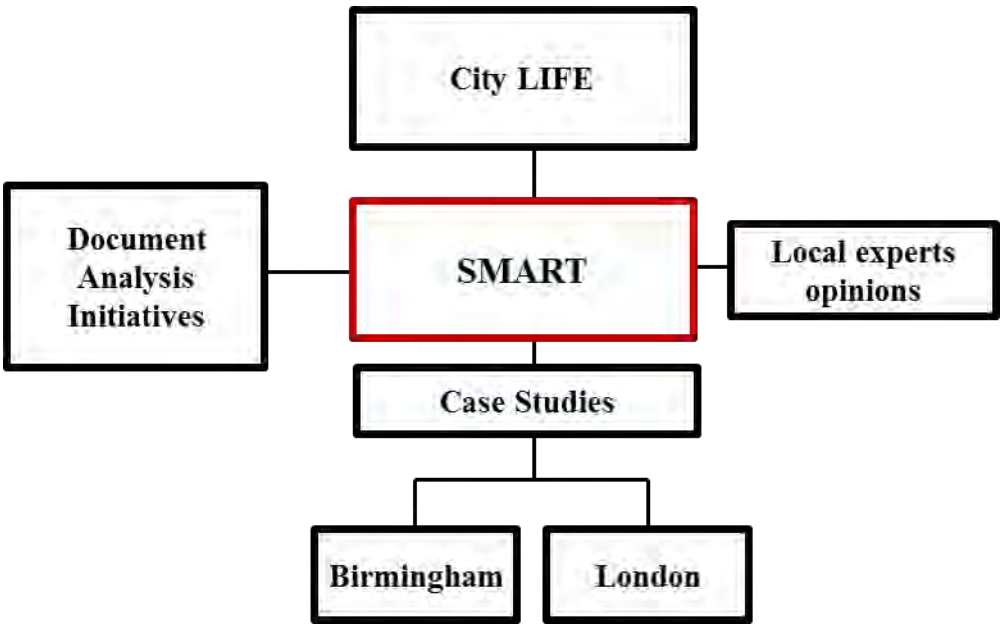

Figure 4.3: Research methodology strand two S2 structure

4.3.2.1 Document analysis of initiatives

In this box, the second set of documents is used: initiatives are assessed on the spreadsheet found in Appendix A-B-C-D. The four lenses relate to the Goals, and in turn, the Goals relate to the Actions. In Appendix A-B-C-D, the initiatives are assessed according to their impact in relation to these Actions.

4.3.2.2 Local Experts' Opinions – Aim

Given the variety of opinions that span across what currently constitutes smartness, the cities' approaches, and the available tools for assessing smart cities, it was expected that different opinions would be reflected in the qualitative research and analysis. As described in Strand 2 of SMART, the local experts' opinions are central to understanding the potential effect of smart initiatives on local populations and their relative importance. Therefore this research used interviews to identify a consensus on the priorities for and potential of smart city initiatives. The aim of the interviews conducted here is to understand the perspectives of the various experts who are able to comment on the conceptualisation of the solutions (and *de facto* establish an underpinning framework of communication on smart systems); these are the people who would be best able to create collaborations for new smart initiatives that would deliver solutions for a number of high-level challenges that cities face – an ideal that would bring about joined-up decision making in the political

agenda (Ersoy, 2017; Alawadhi *et al.,* 2011). This approach is considered as a model for public participation in the creation of smart initiatives, leading to the use of local talent (i.e. those who understand the local context) engaging in a process where the bottom-up agendas influence the top-down policy of the smart city (Capdevila, 2015).

This is a task that addresses Objective F, and informs the recommendations to satisfy Objective G, and is proposed as the public participation component of the SMART. The interviews here were focused on seeking experts' advice in order to provide a combined perspective that might be termed 'locally-informed political thinking' for the smart initiatives, thinking which could be evaluated and adopted by the city in question (Aberbach and Rockman, 2002). It was evident early on that participants would need to be encouraged to engage with all aspects of, and discuss, a subject that might not appear to be clearly defined, and that direct questioning following the provision of a standard introduction to the topic was required since use of technical or digital media alone might lead to biased or unreliable results (Leao and Izadpahani, 2016; Kudo and Granier, 2016). Overall, the outcome of the interviews did not aim to address the specifics of a proposed initiative, but a synthesis of the main discussion points that can influence the early development of the smart initiative and create a context of understanding of how it would fit in the organisation of public life (Bergh, 2015; Waart, 2015; Keta, 2015).

4.3.2.3 Interviews (participants and questions)

The interviewee selection was consistent with the 'academic-commercial-governance' structure (as introduced in Section 2.3), aiming to provide a spherical (i.e. rounded, or balanced) approach of opinions. For this research, at least 5 experts representing each of these categories (though more were contacted in the realm of governance because, for example, this category of stakeholder provided the genesis and ownership of most of the smart city initiatives in Birmingham) were contacted by email, to which was attached a letter with details of the research project, purpose of the research, and the research lead. It also provided communication details for the Department of Civil Engineering and explained the processes of recording, transcription, and safe storage of the transcriptions, clearly identified privacy matters and requested signed consent at the end of the description. Initially emails

were sent to potential participants from the Smart City Commission and Green Commission, both part of the Birmingham City Council, and similarly for London, members of the Mayor of London's Office (part of the London Assembly) were contacted by email. In addition, contact was made at other events (e.g. conferences), where the research was verbally discussed, adding to the number of potential interviews.

The final selection of participants (which also aimed to provide a balance across the academics-commercial-governance domains), who gave written consent for taking part in the interviews, provided a complementary group of individuals who were exceptionally well-placed to comment due to their roles and experience. In Birmingham, , for example, they consisted of a smart cities expert (a Director of major contractor, who was also a member of the Birmingham City Council Smart City Commission), an innovation expert (from Innovation Birmingham), a Policy Advisor (and former member of BCC), the [redacted] Birmingham City Council (BCC) and an academic who previously served as a Director of a leading international consultancy responsible for delivering sustainable outcomes from major Government-funded projects. Table 4.1 shows the positions held by the interviewees. The five participants for the Birmingham case study and four for London provided nine interviews that enabled the author to draw early comparisons between the two cities, underlined by the Strand One conclusions. The preferred location was at their offices (for both cities), where face to face interviews could take place in a situation that would put the interviewees at ease, so the conversation would have a more flexible approach and develop as a conversation rather than simply being confined to replying to the pre-formulated questions (Irvine, *et al.* 2011).

The qualitative analysis didn't aim to provide a comparison between those opinions on smart – such a process would only serve to explore the theoretical approaches and the complexity of the opinions on smart – but was rather to elicit local knowledge on the understanding of smart in this local context and how it (via smart initiatives) would be likely to benefit the local city and its citizens (Hennie, 2002; Guest *et al.,* 2005). Guest (*et al.* 2005); Bergh (2015) suggested that this perspective can be reached with a sample of six or more participants, and hence nine interviews were deemed adequate.

SMART combines the application of CityLIFE and local city experts' opinions, obtained through a series of discussions on smart cities in relation to the particular city context. Ethical approval was obtained (on 29th June 2015; ethical approval ERN_15-0551A) for the interviews, which have been transcribed and can be found in Appendix E & F.

Table 4.1 Experts Interviewed to obtain Local Experts' opinions

Birmingham	**Addressed**	**London**	**Addressed**
Birmingham City Council	Participant 1	Future Cities Catapult	Participant 6
Innovation Birmingham	Participant 2	Smart Cities Consultant, Arup	Participant 7
IT Director Smart Data,	Participant 3	Researcher, Centre for Cities	Participant 8
EU Policy Advisor	Participant 4	Writer Urbanist	Participant 9
UoB Academic (Smart Cities)	Participant 5		

4.3.2.4 Limitations: successes and failures of the interviews

The interview questions were identical for both locations, each time referring explicitly to the proposed location, found in Appendix E (for Birmingham) and Appendix F (for London). The interviews were designed to enrich the data and knowledge obtainable from other sources (Strand 1) with opinions based on their local experience, this additional intelligence falling in to the category of being mostly complex and difficult to measure (Richards, 2015). Each interview was categorised into three parts

i. The first focuses on the semantics of the smart city and its initiatives, where the interviewer poses questions on the nature of smartness and smart initiatives, so the interviewee realises the difficulty of addressing aspects of the subject; here an initial discussion on the subject is established in which the interviewees will reveal their professional approach taken on smart.

ii. The second part concerns the stakeholders of the smart city, covering the typology and stakeholder involvement in the smart agenda; here the interviewee could identify with their

own professional agenda and formulate their answer according to their professional perspective.

iii. The third part was on demographics, including questions on their personal focus on living and working. These questions were left until the end so the interviewee could state a preference not to answer without changing the course of the discussion on items (i) and (ii), or else, if they provided an answer, their personal connection to the city in question didn't influence their professional perspective when answering (i) and (ii).

Initial challenges in designing these interviews, including the type and number of the interviewees, considered the participants' willingness and motivation to be part of this research (Adams, 2015). Specifically, in spite of initial encouragement to contact them, none of the members of the Birmingham Smart City Commission and the Green Commission replied to the several emails they were sent. A similar response was obtained for the Mayor of London's Office. Even personal contact with some of the potential participants (e.g. smart cities conferences), which yielded verbal promises that they will be part of the interviews, failed to secure their involvement. Given their position in local governance and interest in delivering a smart city, the fact that many interviews with people from these organisations did not take place is a limitation for this research – if all were interviewed the datasets would have been remarkably complete – and an indication of the willingness to participate in discussions for the local smart agenda. While a comprehensive view from those governing the two cities proved unobtainable, securing the balanced perspectives from a senior group of interviewees via in-depth, semi-structured interviews proved to provide what was needed for the Strand 2 research.

The semi-structured interviews can create a flexible environment for discussion. Having previous knowledge of the challenges of the smart topic in the city in question allowed the interviewer to identify and examine which are the new additions to the subject (Kallio *et al.,* 2016). Contrary to the lack of comprehensive willingness to participate from those in local government, other administration agencies were more approachable. For example, organisations such as the Future City Catapult (London) and Innovation Birmingham were open for communication, which showed that agencies related to the city, and particularly those that aim to bring about change in that city, are a better option

for information exchange. Similarly, those from commercial organisations and individuals that take specific interest in the subject, such as academics or researchers, proved to be more willing participants.

The interviews were transcribed and were emailed to the participants, as a record of the interview having taken place and the topics discussed, noting that interviewees could withdraw at any point during this research if they chose to do so. The records of the interviews provided anonymity throughout the research process.

4.3.2.5 Case studies

S2 is focused on two UK case studies, both cities being the subject of research, in part, by the Liveable Cities research project. They were chosen for S2 to generate a discussion of the results of the S1 analysis. Given the requisite time and level of participation (which would not have been possible according to the duration of the research programme being reported in this thesis), the group discussion could propose additional initiatives, and perhaps even case studies. Therefore, for the requirements of this thesis, these two case studies are used in order to draw comparisons on the efficacy of local 'bottom-up' perspectives to enhance the liveability assessment of the initiatives.

4.4 Tool Additions

SMART (where R stands for resilience) aims to provide a way to capture the city aspirations of contemporary and prospective smart cities, as adopted in the Urban Futures methodology and in turn incorporated in the Liveable Cities methodology (Lombardi 2012 *et. al*; Hunt and Rogers 2014; Rogers *et al*., 2014b; Rogers and Hunt 2019). This addition of resiliency to SMART could provide risk information for smart development and further clarification of the smart city vision, a method often used by corporations to make decisions on technological aspects (Twiss and Jones, 1978).

For example: S2 describes the method of discussing (in this thesis, in interview format) the findings from S1. S2 has been designed to use local experts' opinions to discuss and prioritise the existing initiatives and, if needed, propose new ones that can further enhance the liveability of smart cities: to assess the criteria that should form the main elements of the decision-making process, and

discuss the priorities of initiatives as a strong basis of understanding the complexity, rather than just using the hierarchies involved in the smart city initiatives (Bhushan and Rai, 2004). This thesis implements this vision in Chapter 6, interprets the results according to the context, and suggests priorities and additional liveable initiatives for smartness.

Furthermore, S2 can also contain further citizens' opinions using surveys, and thus provide better informed decision making for local initiatives, as well as a circular dynamic influence of external and internal influences, which could provide a clearer development focus for initiatives and stakeholders (Tsiatsis *et al.*, 2014; Joshi *et al*., 2016).

4.5 Methodology Conclusions

Chapter 4 is the research methodology for this thesis. It has been demonstrated that the existing smart city tools cannot be considered adequate for assessing the liveability of truly smart cities, and that CityLIFE is the most appropriate tool to assess liveability.

For this reason, SMART has been developed to implement CityLIFE in order to assess smart cities in two ways – S1, which is essentially a 'top-down' analysis, and S2, which includes local opinions and therefore includes a 'bottom-up' element – to evaluate the initiatives adopted in the smart agenda of a city. The 'top-down' feed into the analysis relates to initiatives designed and put in place, often by the city authorities, on behalf of the citizens and are described in relevant documentation (S1), whereas discussion with local experts, and local citizens, would support the MCA method and prioritise decisions. In this thesis, due to time and accessibility limitations, S1 is used to explore liveability in four case studies, while S2 demonstrates the application of a fuller analysis by including discussion with local experts, in the form of semi-structured interviews, for two cities (Birmingham and London). Both S1 and S2 offer a holistic approach to the creation of truly smart cities. The findings from S1 are analysed in Chapter 5.

CHAPTER 5: CASE STUDIES (STRAND ONE S1)

5.1 Introduction

SMART was applied in this research to assess whether smart cities would deliver liveability benefits (Actions impacted by initiatives) for society as a whole and individuals if the initiatives introduced to make them smart were successful. Liveability was at the core of the stated visions of the four case study cities and, following the analysis, the research was able to judge whether the initiatives that have been implemented have resulted, or would be likely to result if successful, in enhanced liveability (true smartness). CityLIFE was used to analyse the available datasets, which, as the research reported in the previous chapters shows, can be used to assess whether aspirational initiatives are likely to deliver true smartness. Chapter 5 applied this methodology (Strand 1-S1) to four cities (case studies) to analyse the likely intended (direct) and indirect benefits of their initiatives and hence the impact on the smart cities' liveability performance.

The analysis provided an insight into the benefits of initiatives (both indirect and direct), the timescale over which those benefits are realised, and a star rating (according to what proportion of a city's population has been positively affected) of the current initiatives adopted in the smart agenda. A set of outcomes summarises what cities have achieved with the adopted initiatives and provides further recommendations for true smartness. A direct impact is a primary outcome of the initiative, stated explicitly in the available documentation as an aim and objective. An indirect impact is one that is judged upon review of the documentation, to be a likely significant outcome, but is not intended to be a primary outcome.

However, this judgement was not straightforward, since the many systems that operate in cities are to a lesser or greater degree interdependent, and therefore the influence of any one initiative, or beneficiary, is likely to be extensive. To illustrate this judgement process, the 'Smart City Commission' initiative (initiative number 29 in Appendix A) explicitly aims to the development of the 'Smart City Roadmap'. There is evidently a significant benefit, in terms of direct Actions, to developing a robust stakeholder programme and indirect benefits to creating a range of new jobs and being recognised as a global test bed to trial new technologies and services; adopting a joined-up

approach across sectors (health, social care, housing, waste and energy); provide more personalised services, enable more efficiencies, identify emerging problems and enable more targeted interventions to improve our lifestyle and well-being. In this chapter, the four cities were assessed according to S1 of SMART, exploring their visions and assessing their benefits (direct and indirect), their timescales and their star ratings.

This section describes the assessed impacts on liveability of the smart initiatives: for Birmingham the direct (5.2.2.1) and indirect (5.2.2.2) impacts, for London the direct (5.3.2.1) and indirect (5.3.2.2) impacts, for Copenhagen the direct (5.4.2.1) and indirect (5.4.2.2) impacts, and for Singapore the direct (5.5.2.1) and indirect (5.5.2.2) impacts. The assessment is graphically shown in the overview (Appendix A); however, this section discusses clearly which of the Lenses have been affected, to establish an understanding of the Actions impacted by the initiatives. Using the key words of the assessment in each case aims to provide further understanding and reveal future research opportunities.

5.2 Birmingham UK – Vision

Birmingham City Council's (BCC's) vision focuses on economic growth. Within the vision, there are liveability priorities focused on delivering a secure environment for growth in terms of the needs of the population, accommodation, employment, healthy lifestyles, resources, governance, and skills, all of which converge in the overarching theme of liveability (BCC, 2017b). BCC's 2018-2022 plan focuses on growth for people, with an emphasis on the younger generations, and the place in general, which does not differentiate significantly from the initial overarching theme of liveability (BCC 2018b). Therefore, BCC's aim to sustain a secure, financially viable, and healthy city to satisfy the long-term vision (BCC, 2008) does, by implication, contribute to true smartness.

Appendix A lists 39 Birmingham initiatives that have been initiated mostly by BCC – noting that those initiated by Digital Birmingham, Eastern Corridor Smart Demonstrator and Innovation Birmingham are also part of BCC. Appendix A also includes 'Reach' – the 'star ratings' that are used to describe the impact on Birmingham's population, also lists the benefits arising from the initiatives and an overview, with the cells marked 'X' showing how the direct and indirect impacts of the

initiatives are distributed. The following sections describe the assessment of timescale (Section 5.2.1), benefits (direct and indirect impact of the actions; Section 5.2.2) and the star ratings that show the scale of impact on Birmingham's population (Section 5.2.3).

5.2.1 Timescale of Birmingham's Initiatives

From a total of 39 initiatives in Birmingham, approximately only half are currently active, as shown in Appendix A, in the column 'Reach' (the sixth in the sequence). As summarised in Table 5.1, 18 of the initiatives have been completed and one has a timescale that is unknown.

Table 5.1 Timescale of initiatives for Birmingham

Timescale	Birmingham Initiatives
Total	**39**
A = active	20
C = completed	18
U = unknown	1

Among the active initiatives are those associated with digital and data endeavours (i.e. Big Data Corridor, Data Factory, Smart Routing, and Open Data Forum), development plans (i.e. East Birmingham Prospectus, and Birmingham Development Plan), and co-working spaces (i.e. Innovation Birmingham, Serendip, and Climate KIC). There is no timescale indication for the Smart City Commission (SCC) actions. In contrast, the Smart City Roadmap (which, along with SCC, is managed by Digital Birmingham) has been completed, as has the initiatives connected to funding or organising workshops (i.e. Coding Bham, Small Business Digital Capability Challenge Fund, and Share-PSI 2.0).

5.2.2 Benefits of Birmingham's Initiatives on Liveability Actions

Birmingham's overview (see Appendix A) has 194 cells in total, which show the impact on the Lenses, Goals, and Actions. Sections 5.2.2.1 and 5.2.2.2 analyse the impact, as documented in Appendix A.

5.2.2.1 Direct impact on Lenses

Birmingham's smart initiatives (or projects, which can be found in Appendix A3) show the largest direct impact (75 cells), which occurs in the Society Lens (28 cells). In the Society Lens, benefits are

mostly achieved in the ‘maximise cultural benefit’ action (8 cells) and in the ‘increase the match between city dweller aspirations and wellbeing’ Action (6 cells); all other Actions here have one, two, or three direct impact. This means that ‘enhance community and individual well-being’ is the Goal most affected in the Society Lens.

In the Environment Lens, there are fewer direct impacts (35 cells), with more impacts targeted at ‘ensure resource efficiency’ than at the ‘ensure resource security’ Goal. However, the ‘increase the match between city dwellers’ aspirations and resource secure living’ Action (contributing to the ‘ensure resource security’ Goal) is the most impacted Action (an Action that has a direct impact) from the initiatives (with 8 cells).

Both the ‘maximise cultural services (health benefits, recreation, opportunities for outdoor learning)’ Action (6 cells) and the ‘minimise energy use and waste (including heat and CO_2 emissions)’ Action (5 direct impacts), contributing to the ‘ensure resource efficiency’ Goal, score highly. All other Actions in the Environment Lens have 3, 2, 1, or even zero direct impacts. Interestingly, there is minimal (or no) direct benefit to Actions concerning food, water, materials, and local skills, in terms of either the ‘ensure resource efficiency’ or ‘ensure resource security’ Actions.

Both the Economy & Finance and Governance & Policy Lenses show some direct impacts (6 cells), for example, in Economy & Finance, the ‘maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO_2 emissions)’ Action (5 cells), whereas the ‘uncouple economic vitality from the CO_2 emissions associated with economic growth’ Action is only slightly directly impacted (one cell). Similarly, in the Governance & Policy Lens, there is also some impact (6 cells), mainly in the ‘uncouple governance structures and timescales from political cycles and the ‘colour’ of governing bodies’ (5 cells), whereas in the ‘uncouple policy making and policy timescales from political cycles and ‘colour’ of governing bodies’ Action there is less (one cell).

5.2.2.2 Indirect impact on Lenses

There is a greater prevalence of indirect impacts on Actions in Birmingham (in comparison to direct impacts); in total there are 119 cells. Similar to direct impacts on Actions, indirect impacts are concentrated in the Society Lens (46 cells), with strong support from the initiatives for the 'increase the match between city dweller aspirations and wellbeing' Action (16 cells) and the 'maximise cultural benefit' action (17 cells). There is some indirect impact on the 'promote healthy living and healthy long lives' Action (5 cells) and the 'ensure an enabling social environment to maximise individual capabilities in the context of carbon reduction and resource security' action (4 cells).

Within the Environment Lens (31 cells), initiatives show less of an indirect impact. Interestingly, there is significant indirect impact on the 'maximise cultural services (health benefits, recreation, opportunities for outdoor learning)' Action (11 cells), contributing to the 'ensure resource efficiency' Goal, and the 'maximise sustainable use of local people first (e.g., utilising the local workforce and leveraging local skills) and then maximise the security of supply of non-local people' Action (10 cells), contributing to the 'ensure resource security' Goal. There are some indirect benefits in support of the 'increase awareness of, and interest in, environmental and climate change issues' Action (3 cells), whereas there are minimal or no indirect benefits delivered in terms of the water, waste, and material Actions (either one mark or no cells).

A good concentration of indirect impact is shown in the Economy & Finance (17 cells) and Governance & Policy Lenses (25 cells), where all four Actions show considerable indirect impact. In Economy & Finance, the 'maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO_2 emissions)' Action shown 8 cells and the 'uncouple economic vitality from the CO_2 emissions associated with economic growth' action more—9 cells. In Governance & Policy, the 'uncouple governance structures and timescales from political cycles and 'colour' of governing bodies' action showed 16 cells and the 'uncouple policy making and policy timescales from political cycles and 'colour' of governing bodies' action less (9 cells). The interesting thing to note here is that the initiatives account for 35% (42 of the 119 cases) of

the indirect benefits to these two Lenses, whereas they were designed to impact only 12 of the 75 instances directly (16%).

5.2.3 Star Rating of Birmingham's Initiatives

The star rating (1, 2 or 3 stars, depending on the proportion of the city population impacted by the initiatives, as explained immediately below) was applied to the total number of cells (194), i.e. covering both direct and indirect impacts. A three-star rating was applied to initiatives that would be expected to have a wide impact, covering the whole of the city's population; for example, multimodal transportation methods or planning policies that could affect the city's development (Birmingham Connected and Birmingham Development Plan). In Birmingham, there are 16 three-star initiatives. There are also 9 two-star initiatives that have been considered to have a substantial impact, and yet they do not impact the whole population; for example, business groups (Start-ups, Innovation Birmingham, and Serendip) that embrace a variety of skills and levels of accessibility. There are 14 one-star initiatives that deliver benefits to only a small proportion of the population, for example, when an initiative refers to the generation of specific skills (Coding Birmingham or Business Digital Capability Fund).

While this produces the impression of a spectrum ranging from the whole population (three-star initiatives) to highly-focussed (one-star) initiatives, when the benefits are analysed the picture is somewhat different. The sum of the star ratings is 438 in total for all 39 initiatives, yielding an average reach of 2.25 (438 divided by the number of impacts, which is 194), showing that the initiatives were more generally felt, whether directly or indirectly, by sub-groups or sectors of the population rather than the population as a whole. This finding would be of interest to BCC, which was behind the majority of the smart city initiatives in Birmingham and would wish to see as wide an impact as possible. It raises the question: could the initiatives have been designed to deliver wider benefits to the citizens of Birmingham, where relevant, and/or could additional initiatives have been created to widen the scope of the impacts to reach a larger proportion of the population? This question is revisited in Chapter 6 (6.2.1) and is discussed in detail in Chapter 7 (7.2.3).

5.3 London UK - Vision

London's (i.e. the Greater London Authority's; GLA's) vision considers London to be an international destination and aims to achieve openness; as in to be open to international visitors and to be non-discriminatory to people (not only residents, but also visitors, and those who work or doing business) overall as an ambitious smart city (MoL, 2017b; GLA, 2018c). Recently, the new (Labour-led) leadership has set priorities related to city transportation, the environment, commerce, inexpensive accommodation, and youth prospects (GLA, 2018e, d). While some of these reflect the priorities of the previous (Conservative-led) administration, there are very significant differences, and this exemplifies the influence of political cycles on 'smart' and initiatives adopted in the city. The London Mayor collaborates—to provide services with sectors such as the Mayor's office for Policing and Crime (MOPAC), London Prepared, the Outer London Commission (OLC), the Old Oak and Park Royal Development Corporation (OPDC), the London Legacy Development Corporation (LLDC), Transport for London (TfL), the London Fire and Emergency Planning Authority (LFEPA) and the Wider South East (GLA, 2018f) (who potentially can be part of the smart agenda). The Great London Authority (GLA) (2018g; h; i) consists of 32 London boroughs that all fall under the London Plan's long-term vision (ahead of 2036), which has a focus on development (in terms of the economy and people), diversity, commercial opportunities, environmental protection, and accessibility for everyone (GLA, 2018c).

Appendix B lists London's 46 initiatives along with their star ratings, which describe the impact on London's population. Appendix B lists the benefits deriving from the 46 initiatives and presents an overview, with the cells marked 'X' showing how the direct and indirect impacts of the initiatives are distributed. Section 5.3.1 describes the timescale assessment of London's initiatives mentioned in the current plan (MoL, 2018), Section 5.3.2 analyses the benefits (direct and indirect impact) of London's initiatives, and Section 5.3.3 presents the star ratings for the initiatives to demonstrate the scale of their impact on London's population.

5.3.1 Timescale of London's Initiatives

London, as mentioned, has adjusted its smart agenda due to a change in leadership. This is also evident from the timescale of initiatives. As Table 5.2 shows, 25 initiatives are currently active, 19 of them have been completed, and the timescale for two initiatives is unknown.

Table 5.2 Timescale of initiatives for London

Timescale	London Initiatives
Total	**46**
A = active	25
C = completed	19
U = unknown	2

Active initiatives are now more focused on interacting with the public to build the smart agenda (i.e. Smarter London Together, the Smart London Board, Working with the Boroughs, Sharing Cities, and the New London Plan). Some of the completed initiatives were developed by the previous leadership and are not currently operating (these include Camden Council Residents Index, Sensing London, London Living Lab, Making Sensors a Commodity, and Tower Bridge). Only two initiatives (the Smart London Investor Showcase and Canary Wharf) show no indication of a timescale.

5.3.2 Benefits of London's Initiatives on Liveability Actions

London has a total of 193 (marked) cells (see Appendix B) showing how benefit arising from its 46 initiatives impacts on liveability Actions. Of these, 95 refer to directly impact Actions and 98 for indirectly impacted Actions. Sections 5.3.2.1 and 5.3.2.2 analyse the direct and indirect impacts of the London initiatives respectively.

5.3.2.1 Direct impact on Lenses

The actions of the Society Lens were impacted on the most (38 cells), where the highest direct impacts are on the 'maximise cultural benefit' Action (16 cells), which contributes to the 'enhance community and individual wellbeing' Goal, perhaps reinforcing the vision statement of London being an international tourist destination and open to international commerce. There is also a focus on the 'ensure an enabling physical environment to maximise individual capabilities in the context of carbon reduction and resource security' Action (6 cells), supporting the 'ensure equity (fairness)' Goal. Also,

the ‘minimise the impact of urban density on biodiversity’ Action (in support of the ‘enhance biodiversity and ecosystem services’ Goal) Action is directly impacted (5 cells). All other Actions in the Society Lens show a smaller direct impact (with one, two or three cells).

In the Environment Lens (33 cells), there is once again more of a direct impact in support of the ‘ensure resource efficiency’ Goal (26 cells) over the ‘ensure resource security’ Goal (7 cells). As the overview for London shows, most direct benefits relate to the ‘increase awareness of, and interest in, environmental and climate change issues’ Action (7 cells) and ‘maximise cultural services (health benefits, recreation, opportunities for outdoor learning)’ Action (5 cells). There are three Actions that are equally impacted on and those are: the ‘minimise energy use and waste (including heat and CO_2 emissions)’ Action, the ‘increase the match between wellbeing and minimising high-carbon mobilities while maximising low-carbon mobilities and immobilities of people and objects’ Action, and the ‘increase the match between city dwellers’ aspirations and resource secure living’ Action. All of which saw a low direct impact (4 cells each). Other Actions show even lower direct impact numbers of 3, 2, 1 and even zero. Similar to Birmingham, Actions in the Environmental Lens on food, water, waste, materials and local people are poorly impacted Actions.

The Actions in the Economy & Finance Lens show a considerable direct impact (19 cells). Specifically, the ‘maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO_2 emissions)’ Action is particularly directly impacted (12 cells), while the ‘uncouple economic vitality from the CO_2 emissions associated with economic growth’ Action is impacted less (7 cells). There are far fewer impacts on the Governance & Policy Lenses, with 5 cells on the ‘uncouple governance structures and timescales from political cycles and ‘colour’ of governing bodies’ action and no cells on the ‘uncouple policy making and policy timescales from political cycles and ‘colour’ of governing bodies’ action.

5.3.2.2 Indirect impact on Lenses

The indirect impact of London’s initiatives is similarly distributed between the lenses, with the 98 cells being fairly evenly spread. The indirect impacts in the Society Lens (33 cells) show a strong alignment with the ‘increase the match between city dweller aspirations and wellbeing’ and the

‘maximise cultural benefit’ Actions (10 cells each), both supporting the ‘enhance community and individual wellbeing’ Goal. However, the indirect impact on the ‘ensure equity (fairness)’ Goal is markedly less, while the ‘enhance biodiversity and ecosystem services’ Goal is not supported at all. Since this is true for all four case studies (see Appendix B), this implies that the only way to protect biodiversity as the pressure and environmental constraints on cities grow is to design and implement specifically-targeted initiatives for biodiversity-secure future cities (Rogers, 2018). Other Actions are less strongly impacted (only 1 or 2 cells) or are not impacted at all.

In the Environment Lens in general, there is a low score (28 cells) in terms of indirectly impacted Actions. Although, one Action, ‘maximise cultural services (health benefits, recreation, opportunities for outdoor learning) in cultural services’, shows a relatively high indirect impact (10 cells). Also, the ‘increase awareness of, and interest in, environmental and climate change issues’ Action has some indirect impact (4 cells); all other Actions supporting the ‘ensure resource efficiency’ Goal have a lower impact (3, 2, 1 and zero cells). In support of the ‘ensure resource security’ Goal, the Action to ‘increase the match between city dwellers’ aspirations and resource secure living’ is somehow impacted indirectly (5 cells), and the ‘maximise sustainable use of low-carbon local energy first and then maximise the security of supply of non-local energy’ is indirectly impacted less (2 cells), while there is no indirect impact on the remaining Actions.

A markedly similar indirect impact is evident on the Actions in the Economy & Finance Lens (27 cells). The ‘maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO_2 emissions)’ Action is indirectly impacted (11 cells) and the ‘uncouple economic vitality from the CO_2 emissions associated with economic growth’ Action is impacted even more (16 cells). In the Governance & Policy Lens, there is less of an indirect impact (10 cells). The ‘uncouple governance structures and timescales from political cycles and ‘colour’ of governing bodies’ Action is only slightly indirectly impacted (3 cells), while the ‘uncouple policy making and policy timescales from political cycles and ‘colour’ of governing bodies’ Action sees much greater impact (7 cells).

5.3.3 Star Rating of London's Initiatives

The sum of the star ratings for London's 193 direct and indirect impacts from its 46 initiatives is 419. There are 11 three-star initiatives, delivering benefits to the wider population (e.g.: Working with Boroughs, Infrastructure Map, and Digital Connectivity). The remainder are approximately evenly split between two-star initiatives, which feature in London's smart agenda (19 initiatives, which would be expected to impact a large section, but not all, of the population; for example, London's Datastore, Tech Map, and Environmental Performance for Small Businesses), and (16) initiatives that have benefits for groups and communities. The average reach of the initiatives (the sum of the star ratings, 419, divided by the number of impacts, 193, yielding an average of 2.17) shows that the initiatives were more generally beneficial, whether directly or indirectly, for the majority of the population rather than sub-groups or sectors, in contrast to Birmingham (which had an average reach of 1.67).

5.4 Copenhagen, Denmark – Vision

Copenhagen's City Council (CCC) is the main governance body for the city of Copenhagen (CoC, 2018a). The vision for the city is deeply rooted in liveability, which is also the main thinking behind its smart approach. The five main priorities of CCC are: a "*liveable green city*" (carbon neutral by 2025), sustainability, development, connectivity (local and international), and electoral system information (CoC, 2018a; Mikkelsen, 2018). Copenhagen's aspiration of being the most liveable city in the world is framed around its prioritisation of leisure and its main means of transport, primarily planning for cycling (CoC, 2018b, c). Copenhagen has been listed among the ten most liveable cities internationally and has taken first place in the rankings twice (Monocle, 2014).

Appendix C lists Copenhagen's 59 initiatives along with their star ratings to describe their impact on Copenhagen's population and lists the benefits deriving from the initiatives and presents an overview, with the cells marked 'X' showing how the direct and indirect impacts of the initiatives are distributed.

5.4.1 Timescale of Copenhagen's Initiatives

Copenhagen's 59 current initiatives are mostly active. Table 5.3 shows that 55 initiatives are active; there are only four completed initiatives that were designed to have a short duration (often due to funding or assigned resources running out). These four, all IBM initiatives, are described in the report on Copenhagen's Smart Cities Challenge (Copenhagen Open Value Network, Integrated end-to-end energy model, Transportation and Building Initiatives, and Governance Body; IBM, 2013).

Table 5.3 Timescale of initiatives for Copenhagen

Timescale	Copenhagen Initiatives
Total	**59**
A = active	55
C = completed	4
U = unknown	0

5.4.2 Benefits of Copenhagen's Initiatives on Liveability Actions

Copenhagen has implemented 59 initiatives (as shown in Appendix C), which have had 235 direct or indirect impacts on Actions that support liveability. Of those, 199 are direct impacts, described in Section 5.4.2.1, and only 36 are indirect, described in Section 5.4.2.2.

5.4.2.1 Direct impact on Lenses

Copenhagen's initiatives have direct impacts on all four Lenses: a small number (9 of the 199) are targeted at Policy & Governance, while 26 are targeted at Economy & Finance; 64 are targeted at the Society Lens and 100 are targeted at the Environment Lens.

In the Society Lens (64 cells), all (apart from one: 'minimise the impact of urban density on biodiversity') are impacted upon. Here, the highest impact is shown in support of the 'ensure an enabling physical environment to maximise individual capabilities in the context of carbon reduction and resource security' Action (22 cells). Also strongly supported are the 'ensure an enabling governance environment to maximise individual capabilities in the context of carbon reduction and resource security' Action (10 cells) and the 'ensure an enabling economic environment to maximise individual capabilities in the context of carbon reduction and resource security' Action (9 cells). All

other Actions have been impacted upon less, although each one has benefitted to a significant degree (between 3 and 6 direct impacts).

An even larger number of impacted Actions is shown in the Environment Lens (100 cells), with those Actions in support of resource efficiency (82 cells) being directly impacted more than those supporting resource security (18 cells). For example, 'minimise energy use and waste (including heat and CO_2 emissions)' (34 cells) is clearly a primary target of Copenhagen's initiatives, while 'increase the match between wellbeing and minimising high-carbon mobilities while maximising low-carbon mobilities and immobilities of people and objects' (16 cells) shows a strong focus on transport to help achieve this outcome. Additionally, all other Actions regarding resource efficiency (apart from 'minimise food use and waste', which was not supported at all) were directly impacted upon by either four or five initiatives, showing a remarkably balanced approach to improvements in the Environmental Lens. Although Actions in support of the 'ensure resource security' Goal exhibited less direct impacts, there is a strong focus on energy security (the 'maximise sustainable use of low-carbon local energy first and then maximise the security of supply of non-local energy' action saw a healthy direct impact (12 cells) and an attempt to align this with the wishes of its citizens ('increase the match between city dwellers' aspirations and resource secure living' is directly impacted less (3 cells) and, unlike the two UK case studies, shows some recognition of the benefit of employing local people ('maximise sustainable use of local people first (e.g., utilising the local workforce and leveraging local skills) and then maximise the security of supply of non-local people' is much less directly impacted (1 cell). However, there is no apparent attempt to influence the Actions dealing with the security of food supplies and materials.

In the Economy & Finance Lens (26 cells), there is a strong focus on liveability (the 'maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO_2 emissions)' Action) (9 cells). As this incorporates minimising harmful atmospheric emissions, the 'uncouple economic vitality from the CO_2 emissions associated with economic growth' Action is directly impacted (17 cells), again pointing to a strong focus on environmental concerns. Relatively few of the initiatives focus on the Governance & Policy Lens (9

cells), and those that do have a stronger focus on policy-making than governance structures: 'uncouple governance structures and timescales from political cycles and 'colour' of governing bodies' is directly impacted twice (2 cells) and 'uncouple policy making and policy timescales from political cycles and 'colour' of governing bodies' is directly impacted to a greater extent (7 cells).

5.4.2.3 Indirect impact on Lenses

The assessment of the indirect impact on Actions shown in the overview in Appendix C shows that there is far less indirect impact (36 cells) than direct impact (199 cells), indicating that Copenhagen's initiatives are closely targeted.

Here, there is some impact on the Society Lens (10 cells), with the 'promote healthy living and healthy long lives' Action (4 cells) and the 'enhance community and individual wellbeing' Goal being supported most. However, this perhaps reflects that the primary target of the initiatives in the Social Lens is to support the 'ensure equity (fairness)' Goal (which has 47 cells in terms of direct impact and only 4 cells in terms of indirect impact).

The Environment Lens shows an even smaller set of indirect impacts on the Actions (6 cells). As suggested above, this may because the initiatives in Copenhagen are more closely focussed on direct benefits, which is also reflected in the lack of documentation of the secondary impact of some of the initiatives (numbers 19-46 Appendix C). In the 'ensure resource efficiency' Goal, the 'minimise energy use and waste (including heat and CO_2 emissions)' Action shows evidence of indirect impact (2 cells), once more reflecting the idea that this is a high priority for the city. One supports the 'maximise cultural services (health benefits, recreation, and opportunities for outdoor learning)'Action (1 cell), the second 'minimise energy use and waste (including heat and CO_2 emissions, while the remainder are not indirectly impacted. In the 'ensure resource security' Goal, there is one indirect impact (1 cell) on three Actions; these are: 'increase the match between city dwellers' aspirations and resource secure living', 'maximise sustainable use of low-carbon local energy first and then maximise the security of supply of non-local energy', and 'maximise sustainable use of local people first (e.g., utilising the local workforce and leveraging local skills) and then

maximise the security of supply of non-local people', with no impact (zero cells) on the rest of the Actions.

Interestingly, there is a relatively high number of indirect impacts in the Economy & Finance Lens (14 cells), with 'maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO_2 emissions)' having 10 cells, which reinforces Copenhagen's long-term vision that the economy is inextricably linked to socially-and environmentally-orientated initiatives. There is less of an indirect impact on the 'uncouple economic vitality from the CO_2 emissions associated with economic growth' Action (4 cells); yet 17 initiatives targeted this Action directly. So it can be concluded that both Economy & Finance Actions are strongly impacted upon by the initiatives. As for indirect impacts, there is a relatively small emphasis on the Governance & Policy Actions (6 cells) with 'uncouple governance structures and timescales from political cycles and 'colour' of governing bodies' having 4 cells and 'uncouple policy making and policy timescales from political cycles and 'colour' of governing bodies' having 2 cells.

5.4.3 Star Ratings of Copenhagen's Initiatives

Copenhagen's 59 initiatives support the Actions (directly or indirectly) in a total of 235 cells (i.e. there are 235 impacts in total). Applying engineering judgement to estimate the reach of the initiatives – i.e. allocating a star rating to each initiative – and summing the star ratings yields a total of 566. The average reach of the initiatives (572 divided by 235 impacts) is 2.43, which shows that the initiatives were markedly more beneficial generally, whether directly or indirectly, for the majority of the population rather than sub-groups or sectors. This finding contrasts favourably with both UK case studies: Birmingham produced an average of 2.25 and London 2.17.

More specifically, 24 initiatives are rated with three stars, affecting most or all of the population, for example, People and Flows, Environment and Climate, World's first Carbon Neutral Capital, Copenhagen Leading Smart City, Energy Efficient Buildings, and Treatment of Organic Waste. More were judged to be two-star rated initiatives (32) – for example, Open Data, City Data Exchange, Pharma Logistics, Innovation and Profiling, Land Wind Turbines, Bidding Partnership for State Wind Turbine, Procurement, Project Management – in which the descriptions indicated that the business

cases affected a wide group, yet not the whole population. There are only three initiatives with a one-star rating (Street Lab, Energy Block, Offshore Wind Turbines), i.e. those for which the descriptions indicated that they involve only a small part of the community in specific technology developments.

5. 5 Singapore – Vision

Singapore's vision is founded on two factors: the Singaporean Prime Ministerial leadership aiming to strengthen the economy and the country's liveability, and the implementation of national policies (Strategic National Projects, Open Data, Living Laboratory, Industry and Start-Up Ecosystem, Cybersecurity and Data Privacy, and Computational Capabilities and Digital Inclusion; SNS, 2018). The relationship between liveability and the economy can be clearly perceived through citizens' ability to connect to the government's digital service system, which specifically aims to support the Singaporean community, providing access to information for efficiency and the prospective creation of businesses through open data (GovTech, 2018). It is evident that digitalisation is the main factor in enhancing liveability – connecting the community to government services and digital technology – and this can also provide economic benefits.

Appendix D lists Singapore's 52 initiatives, along with their star ratings describing the impact on Singapore's population; lists the benefits deriving from the initiatives; and presents an overview, with the cells marked 'X' showing how the direct and indirect impacts of the initiatives are distributed. Singapore's 52 initiatives impact on the Actions across 125 cells.

5.5.1 Timescale of Singapore's Initiatives

Singapore, like Copenhagen, has a high number of current initiatives (Table 5.4): out of the 52 initiatives, 41 are currently active, six have been completed and five do not specify a timescale in their descriptions.

Table 5.4 Timescale of initiatives for Singapore

Timescale	Singapore Initiatives
Total	**52**
A = active	41
C = completed	6
U = unknown	5

Active initiatives include those initiated by the SNS and GovTech, mostly relating to Government digital systems and access to them (i.e. Healthcare Solutions-Digital, Aging, and Homecare, Electric and Self-Driving Vehicles, and Access to Grants along with Cashless Society). Those for which there is no indication of timescale are Singapore's Youth Council, GITSIR, National Authentication Framework, Technology Associate Programme, and Agile Development.

5.5.2 Benefits of Singapore's Initiatives on Liveability Actions

Singapore adopted 52 initiatives, which show a total of 125 areas of impact (cells), approximately equally distributed between direct and indirect impacts: 64 cells for direct impacts and 61 for indirect impacts. Both will be analysed in 5.5.2.1 and 5.5.2.2.

5.5.2.1 Direct impact on Lenses

In total, there are 64 direct impacts, as shown in the overview (Appendix D), with the highest impact in the Society Lens (28 cells). Here, the 'increase the match between city dweller aspirations and wellbeing' Action is directly impacted on a relatively high number of cells (12), while 'maximise cultural benefit' is also significantly impacted upon (7 cells), both actions supporting the 'enhance community and individual wellbeing' Goal. The 'Ensure equity (fairness)' Goal is impacted upon less, although the 'ensure an enabling social environment to maximise individual capabilities in the context of carbon reduction and resource security' Action is impacted to an even lesser extent (5 cells), and the 'ensure an enabling physical environment to maximise individual capabilities in the context of carbon reduction and resource security' Action shows little impact (1 cell). There is no impact on the other two Actions supporting this Goal and, likewise, there is no impact on the 'enhance biodiversity and ecosystem services' Goal.

Interestingly, the Environmental Lens has been far less affected by the initiatives (17 cells), either directly or indirectly, and where it has been affected, it is in respect of the most 'socially beneficial' environmental Actions (i.e. supporting health and wellbeing and making provision for local people in the workforce as opposed to addressing resources). In support of the 'ensure resource efficiency' Goal, a direct impact on the 'maximise cultural services (health benefits, recreation, opportunities for outdoor learning)' Action is evident (7 cells), and the same can be said for the 'increase the match

between wellbeing and minimising high-carbon mobilities while maximising low-carbon mobilities and immobilities of people and objects' Action (3 cells). In support of the 'ensure resource security' Goal, 'maximise sustainable use of local people first (e.g., utilising the local workforce and leveraging local skills) and then maximise the security of supply of non-local people' is directly impacted to a greater extent (6 cells), while the 'increase the match between city dwellers' aspirations and resource secure living' Action is impacted upon only once (1 cell), while the remainder show no impact at all.

In the Economy & Finance Lens (9 cells), the 'maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO_2 emissions)' Action is directly impacted the most (8 cells) – the Action with a stronger focus on people – while only one initiative directly supports the 'uncouple economic vitality from the CO_2 emissions associated with economic growth' Action (which has a stronger environmental focus). In the Governance & Policy Lens (10 cells), there is a direct impact on the 'uncouple governance structures and timescales from political cycles and 'colour' of governing bodies' Action (6 cells) and on the 'uncouple policy making and policy timescales from political cycles and 'colour' of governing bodies' Action (4 cells).

5.5.2.2 Indirect impact on Lenses

The number of indirect impacts on Actions is not dissimilar to the number of direct impacts, and yet the 61 indirect impacts are strongly weighted towards the Social Lens (41 cells), with 10 cells in the Environmental Lens, 3 in the Economy & Finance Lens and 7 cells in the Governance & Policy Lens. This reinforces the idea that Singapore is putting its people first.

In support of the 'enhance community and individual wellbeing' Goal, there is huge indirect impact in respect of the 'increase the match between city dweller aspirations and wellbeing' and 'maximise cultural benefit' Actions (15 cells each), while the 'promote healthy living and healthy long lives' and 'minimise ill-being' Actions are each supported by 4 initiatives. The 'ensure equity (fairness)' Goal is evidently far less important (only 2 indirect impacts) and there is no impact at all on the 'enhance biodiversity and ecosystem services' Goal.

There is even less of an indirect impact (compared to direct impact) on Actions in the Environmental Lens (10 cells), with only the 'maximise cultural services (health benefits, recreation, opportunities for outdoor learning)' Action (3 cells) and the 'maximise sustainable use of local people first (e.g., utilising the local workforce and leveraging local skills) and then maximise the security of supply of non-local people' Action (7 cells) being supported. All other Actions show zero indirect impact, which shows little indirect consideration for the Environment Lens.

The Economy & Finance Lens shows little indirect impact overall (3 cells), with the 'maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO_2 emissions)' action being impacted by 2 cells and 'uncouple economic vitality from the CO_2 emissions associated with economic growth' being impacted even less (1 cell).

In the Governance & Policy Lens (7 cells) the 'uncouple governance structures and timescales from political cycles and 'colour' of governing bodies' Action is indirectly impacted (4 cells) and the 'uncouple policy making and policy timescales from political cycles and 'colour' of governing bodies' Action is indirectly impacted to a lesser extent (3 cells).

5.5.3 Star Ratings of Singapore's Initiatives

The star rating has been applied to the 52 initiatives adopted in Singapore. The overall (direct and indirect impact) score is 266. This has resulted from the 19 three-star initiatives, benefitting the whole population of Singapore (e.g. Assistive Technology, Telehealth, Contactless Payment, Digital Government, Citizen Connect, Smart Nation, Social Service); the 17 two-star initiatives (e.g. Leveraging Technology, Business Grants Portal, Design Challenge Call for Proposals, Smart Nation Fellowship, National Trade Platform, TRANS Grant, SME Portal), which show a narrower focus on beneficiaries; and the 16 one-star initiatives (e.g. Self-Driving Vehicles and Standards, GovTech Cloudstore, Young Change Makers, Leadership and Service Award, Singapore Youth Award, Singapore-ASEAN Youth Fund), which affect only a small proportion of the population, such as young people or those interested in autonomous vehicles (or other more narrowly-focussed technology).

Singapore's 52 initiatives support the Actions (directly or indirectly) in a total of 125 cells (i.e. there are 125 impacts in total). Applying engineering judgement to the description of each initiative, thus allocating a star rating to estimate the reach of the initiatives and summing up the star ratings yields a total of 266. The average reach of the initiatives (266 divided by 125 impacts) is 2.12, which shows that the initiatives were marginally more generally beneficial, whether directly or indirectly, for the majority of the population than sub-groups or sectors.

5.6 Comparison of the Impact of Initiatives on CityLIFE Actions

Four cities have been assessed according to the impact on liveability actions the initiatives adopted in each of their 'smart city' programmes have had. There were different amounts of initiatives, timescales, and star ratings for each city, and these are discussed in this section. However, some initiatives had a wider benefit across the actions, as demonstrated for each city in Appendices A-B-C-D, whereas other initiatives were more narrowly-focussed in terms of their benefits.

For example, the Birmingham Development Plan 2031 has a total of 18 cells (both direct and indirect impact), whereas the West Midlands Open Data Forum impacts only one Action. In London, London's Smart Park 'Sustainable Districts' initiative supports (directly or indirectly) 14 Actions (the highest for London), while the descriptions of London Sharing Cities, Infrastructure Map, and IBM and Wimbledon Data indicate that they each only impact one of the Actions. In Copenhagen, a few Actions have multiple impacts (for example, 27 for City of Cyclists, 22 for Health Care, 21 for Energy Efficient Buildings). In Singapore, initiatives tend to be more focussed, with a lower distribution of benefit across the Actions: HealthHub Portal, National Steps Challenge, and TeleHealth have been judged as having an impact on 6 Actions, while the rest of the initiatives show a smaller number of cells. In total, as shown in Appendix C (and summarised in Figure 5.1), Copenhagen has adopted the highest number of initiatives out of the four cities in support of its aim of being a smart city, followed by Singapore, London, and Birmingham (Figure 5.3).

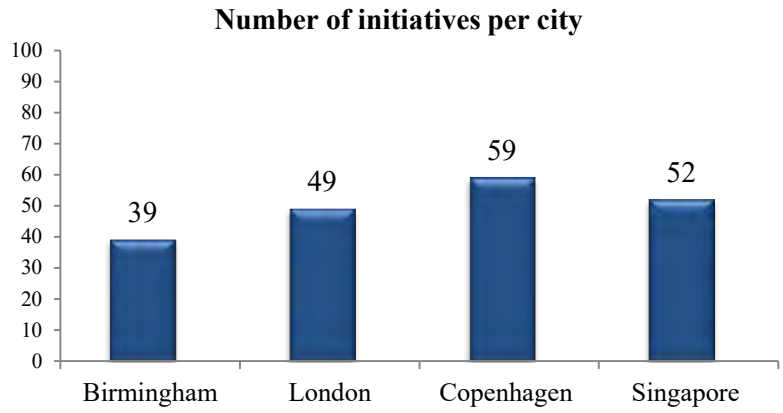

Figure 5.1: Smart city initiatives per city

One might expect that the number of adopted initiatives would reflect the population or the city size. In that case, London would have the highest number of initiatives and Copenhagen the smallest. This is not what is happening. For this reason, the results were analysed in terms of likely impact (direct and indirect) and reach (in terms of the proportion of the city's population affected). A general approach of analysing the impact per capita would provide a skewed approach, for example the direct impact per capita would be greatest in the city with the largest population, and this in turn would require a greater focus on the detail of the likely beneficiaries, which would introduce the need for far more detailed subjective judgements to be made and thus greater uncertainty in the analysis. More specifically, it would require a deeper and more nuanced understanding of the specific elements of the population impacted and how they would be impacted, topics which might be an opportunity for further research but which would have compromised the effectiveness of the SMART analysis. Nevertheless, this research is able to show a clear indication between the proportions of citizens that are likely to be beneficially impacted and the number of city initiatives. As Figure 5.2 shows, the number of initiatives varies. For example, London has the highest number of initiatives per head (per million population), (London= 49 ÷ 8.1739 = 5.9) (Census, 2011a); and Birmingham has the lowest (Birmingham = 39 ÷ 1.0730 = 36.3) (Census, 2011b). There is a similar amount of initiatives per head (of the population) for both Copenhagen (Copenhagen = 59 ÷ 5.3954 = 10.9) and Singapore (Singapore = 52 ÷ 5.1837 = 10), which shows that city size is not relative to the number of initiatives

(Statistics Denmark, 2011; MoFA, 2011). This shows that, according to population size, Birmingham has the highest number of initiatives (per million population).

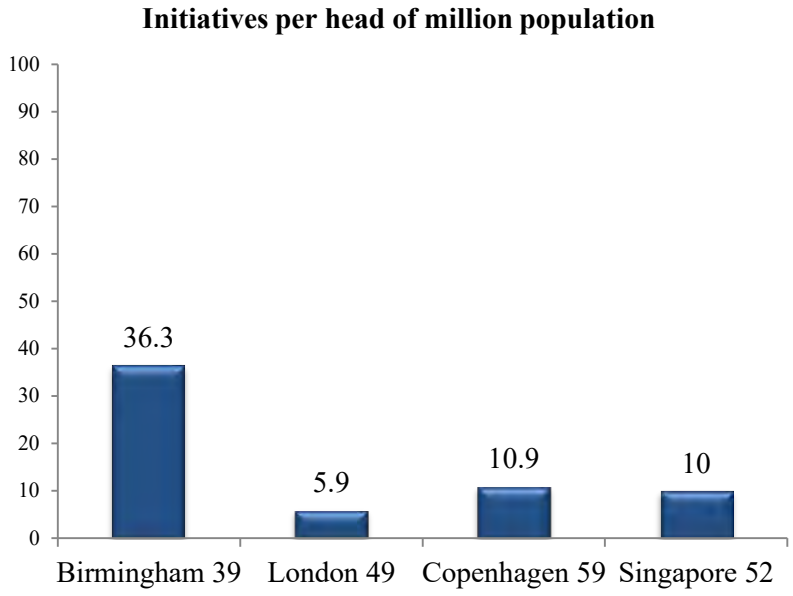

Figure 5.2: Smart city initiatives per million head of population

However, other factors can influence the number of adopted initiatives, for example, access to national and international funding, leadership, and collaborations happening both in the city and internationally. Even so, the smart city agenda is surely a good indication of the initiatives potential; meaning that there is thinking and action in terms of smartness in the city.

From the comparison shown in Figure 5.3, Copenhagen shows the highest number of liveability Actions supported by its initiatives (235), while Birmingham and London have a remarkably similar number (194 and 193 respectively,) and Singapore, markedly, has the lowest number (at 125, this is little more than half of the same figure for Copenhagen and less than two-thirds of the amount of liveability actions in the UK case studies). These absolute figures are important – it is for each city to decide on the number of initiatives that it adopts and how those initiatives are targeted to bring about benefits to the three traditional pillars of sustainability (society, the environment, and the economy), and to governance. Since all four case study cities cite liveability in their vision in some way, the number of liveability Actions supported by the initiatives is relevant. Such analysis underpins the

topic being explored in this thesis: whether smart city initiatives are 'truly smart' by delivering more sustainable, resilient and liveable cities.

However, these data reveal a further important aspect in terms of the initiatives' ability to deliver multiple benefits – if any single initiative can be designed to deliver benefits in support of several liveability Actions, then it can be argued to be more effective (Rogers, 2018). Inevitably, for some initiatives, this would be neither possible, nor necessarily desirable, and therefore it is the portfolio as a whole that should be judged. This can be achieved by dividing the sum of the liveability Actions supported by the number of initiatives, which shows that Birmingham (194 ÷ 39 = 5.0) is the most successful in delivering multiple benefits from its portfolio of initiatives, followed by Copenhagen (4.0) and London (3.9), with Singapore (2.4) markedly the least effective in this regard.

Looking at the distribution of liveability Actions supported, i.e. taking a more holistic view, Birmingham and London show an approximately similar amount of impacts on the Social and Environmental Lenses, while the priority of Copenhagen's initiatives is clearly focussed on the Environmental Lenses, and Singapore shows most support for liveability Actions in the Society Lens. Nevertheless, all four cities show, remarkably, an approximately equal number in the Society Lens, suggesting a uniform approach towards the societal aspect of smartness.

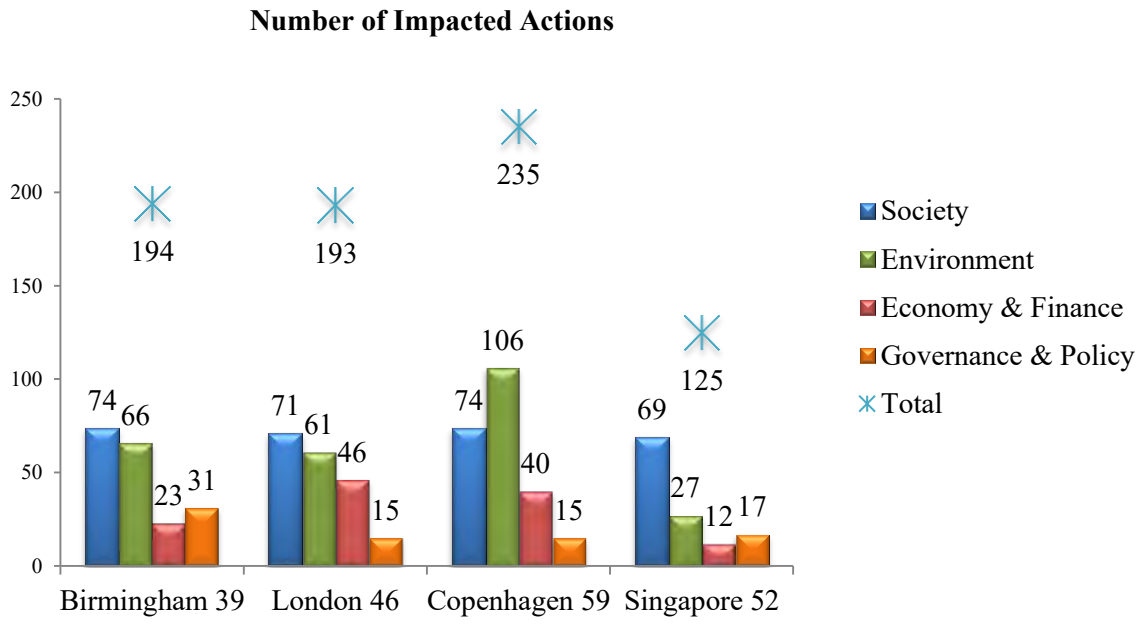

Figure 5.3: Number of actions impacted upon by the 'smart city' initiatives for each case study

Both Economy and Finance and Governance and Policy have fewer liveability Actions impacted upon by the initiatives, possibly due to the fact that the adopted initiatives were designed by the local (or central, in the case of Singapore) government. Also, these initiatives are often supported by local stakeholder funding, or are funded by the local/central government. Therefore, often, the initiatives themselves do not inherently prioritise economic benefits. Almost all smart cities, carry out decision-making locally, however, national policies can affect a city's policy (smart or liveable). For example, decision making within a city's context, Brexit, where London in particular might be affected in terms of altering previous compliance to the EU policy. Despite the Mayor of London's aims for a Smart London, European policy constraints (and funding) and international policy can affect decision-making and provide opportunities for future smart initiatives proposals.

However, in the case of London, because of the involvement of commercial organisations (e.g. Arup) in the initiatives, there is a significant impact on the liveability Actions in the Economy & Finance Lens (46 Actions supported), and this is also true of Copenhagen (42 Actions supported), since the initiatives involved the development of green businesses (CC, 2018; Gilles, 2012). While this is of lesser importance in Birmingham (23), and less still in Singapore (12), Birmingham has a markedly greater focus on liveability Actions in the Governance & Policy Lens (31 Actions supported; approximately twice as high as those of the other case study cities).

As this discussion has demonstrated, due to the contextual differences, the number of initiatives should not be the only indication of whether a city is becoming smart(er). For this reason, a further comparison will assess the timescale (Figure 5.4), benefit (Figure 5.5), and star rating (Figure 5.6) of each initiative of these four cities to provide further insight.

5.6.1 Comparison of Timescales

Among the four cities, there are differences between the timescales of their initiatives. Specifically, as Figure 5.4 shows, Copenhagen has the highest number of active initiatives (55 active of a total of 59 initiatives), followed by Singapore (41 active of a total of 52 initiatives), with both UK cities showing similarities in terms of timescale: London has 25 active initiatives out of its total of 46, and Birmingham has 20 active out of its total of 39.

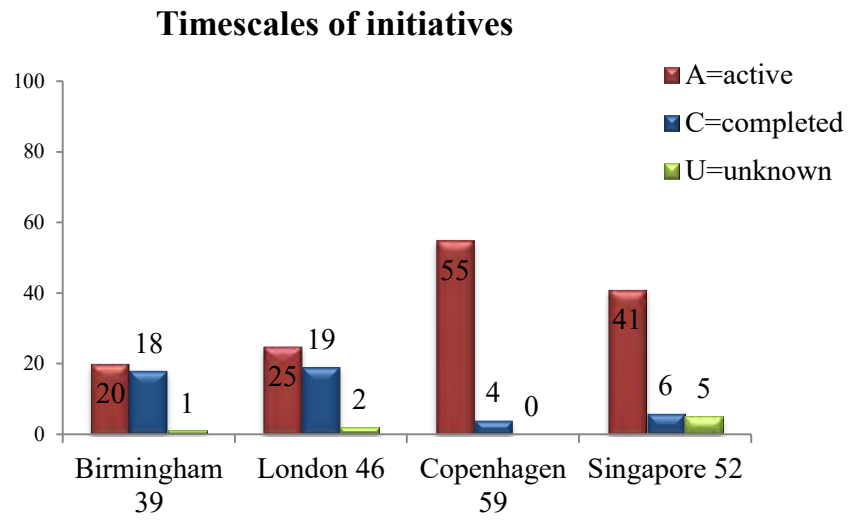

Figure 5.4: Distribution of timescales for each case study city's initiatives

Although this cannot be considered a definite factor in the development of a city's true smartness, the high number of active initiatives shows that there is a lot of activity currently underway, and these activities (initiatives) have the potential to keep delivering benefits –providing that they are assessed and developed according to the SMART (as there is no current evidence in the smart agenda of a city's council that the intended benefits were delivered).

Singapore also has a high number of active initiatives (and relatively few that are inactive). The two UK cities show similarities in the number of active and completed initiatives. It can be concluded here that the completed initiatives were designed with a specific timeframe in mind, often due to funding constraints, and once completed they will perhaps continue to deliver benefits without the need for further funding – i.e. once a process or system is in place, then the initiative has achieved its aims. Further analysis of the relevant benefits and star ratings is necessary to provide more insights into the 'liveability successes' in these smart cities, although this discussion reinforces the point that each city starts from its own baseline, dictated by its own unique context, and the delivery of enhanced liveability progressively influences this context: smart initiatives (and, generally, the smart agenda) is a dynamic local process that is also influenced by global contextual changes. For this reason, it is the overall trends reported herein that are perhaps more beneficial to a city than any

specific detail, since it is these trends that can be used to inform a city's actions, and investments, with regard to its current and new initiatives.

5.6.2 Overall Benefits (Direct and Indirect Impacts) of Initiatives

The overview for the four cities shown in the appendices (A-B-C-D) is summarised in Figure 5.5, which shows that Copenhagen's initiatives achieved the greatest direct benefit to the CityLIFE Actions (199 direct impacts, allied with 36 indirect impacts). This suggests that liveability is a specific priority for the city. London, with 95 direct impacts and 98 indirect impacts, lies second in this respect, while Birmingham (75 direct impacts and 119 indirect impacts) achieves roughly the same overall benefit (194 impacts, as opposed to 193 in London) by virtue of its initiatives being designed to achieve 'multiple benefits', as discussed earlier. Figure 5.4 reiterates the observation that Singapore's relatively large number (52) of smart city initiatives are more closely focussed, with 64 direct impacts and 61 indirect impacts.

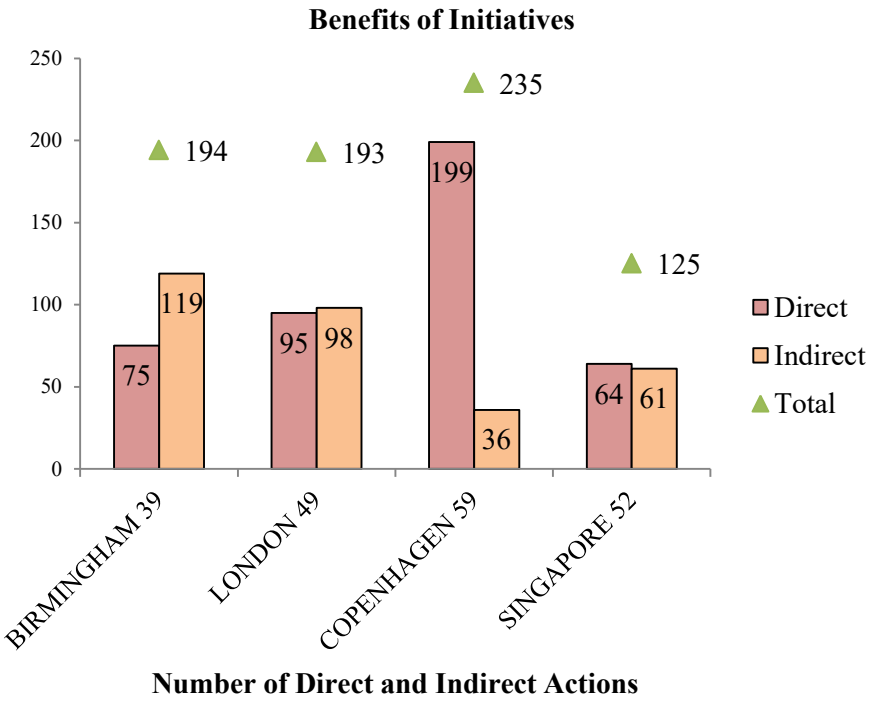

Figure 5.5: Summary of direct and indirect impacts on liveability Actions

5.6.3 Star Rating Comparison for the Four Cities

The three-star rating is applied to each smart city initiative to show the scale of its impact, or 'reach', on the city's population. Figure 5.6 shows the sum of the star ratings for each city. Copenhagen has a

total of 572 from its 59 initiatives, followed by London with 419 from 49 initiatives, Birmingham with 438 from 39 initiatives, and Singapore with 255 from 52 initiatives.

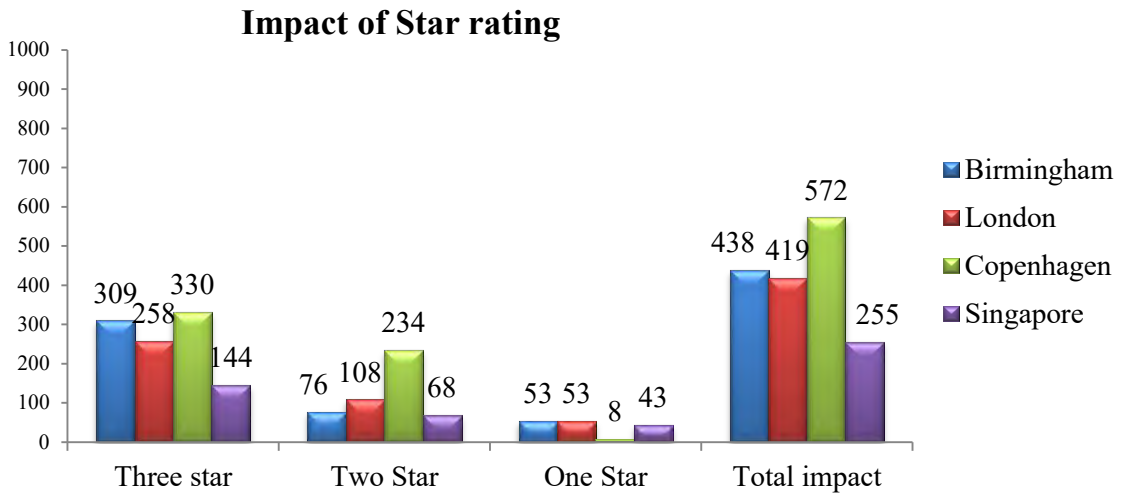

Figure 5.6: Reach (star) rating for four case studies

However, these data need to be looked at in the context of the total number of impacts that each city's initiatives have delivered (Figure 5.6 and 5, 7), since dividing the sum of the star rating by the sum of the impacts defines the average 'reach', therefore, whether the initiatives in general aim to impact most of the city's population, or sub-groups (of whatever type). This places Copenhagen ahead of the other three case study cities (572 ÷ 235 = 2.43) in terms of generally targeting the whole population rather than sub-groups. [A value of 3.0 would mean that all initiatives targeted the whole population of the city, while 1.0 would mean that all initiatives targeted only a relatively small sub-group.] Birmingham lies at the other end of this scale (438 ÷ 194 = 2.25), while the initiatives of London (419 ÷ 193 = 2.17), and Singapore (255 ÷ 125 = 2.04) marginally favour the whole population. However, as reported above, this finding needs to be considered alongside the ability of the initiatives to deliver multiple benefits, with Birmingham leading markedly in this respect.

Figure 5.7 below shows the average reach of initiatives for the four case studies. Overall, Copenhagen shows the highest average (2.43) followed by Birmingham (2.25), then London (2.17) and the lowest average was reached by Singapore (2.04).

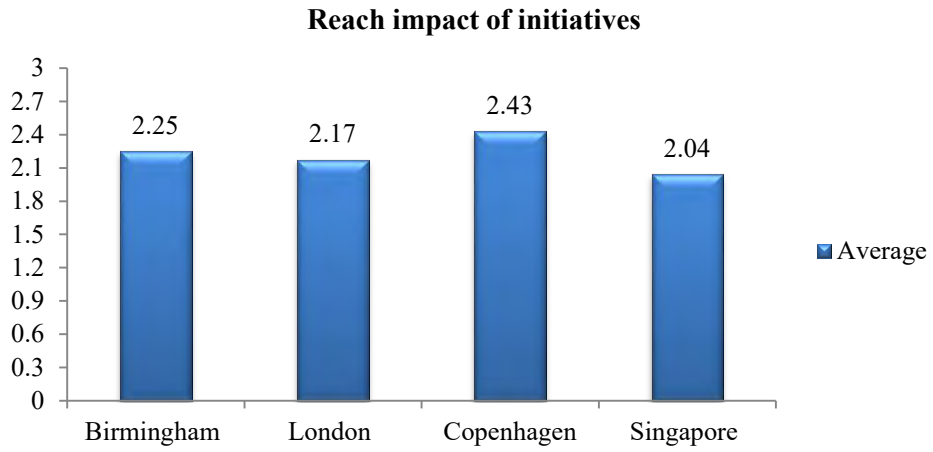

Figure 5.7 Average impacts of initiatives for the four case study cities

This shows that Copenhagen has a significantly better reach between the four, i.e. the analysis showed that initiatives in Copenhagen impacted a wider portion of the population. This is consistent with the observation that Copenhagen also had the highest number of three-star initiatives and, remarkably when compared to the other three cities, only 8 one-star initiatives.

5.7 Conclusions on Smart S1

Conducting a comparison of the four case studies has been an ambitious undertaking. Due to the different contexts and city aspirations (as either described or implied in different documents), it has proven difficult to compare their relative standings, progression towards smartness, and, for the purposes of this thesis, 'true smartness'. One particular reason for the difficulty is the complexity of the interpretation of smart: the very meaning of smart being perceived and reported differently (Cavada *et al.,* 2014) – different cities interpret 'smart' and 'liveability' differently even though their visions appear consistent. It is, however, possible to understand smartness in terms of enhanced liveability through an exploration of the four case studies implementing the SMART, which uses the CityLIFE methodology to assess liveability, a new tool developed in this research to specifically address the difficulties and complexities of understanding what truly smart is.

The analysis starts with a presentation of the different city visions. Birmingham's vision is to secure a financially viable future environment for the needs of the growing population (economic growth is a major priority), yet with a strong focus on living quality within environmental parameters,

therefore there is an overarching theme of liveability. It aims to achieve this long-term enhancement in liveability by adopting a digital agenda for smartness. In contrast to this inward view, London sees itself beyond the UK context, with an ambition to be fair and open to people – residents and visitors alike. Of course, London also has 'internal' priorities aimed at the local context, mainly regarding the challenges of moving around the city, working and living, and also enhancing future prospects for younger generations. However, similar to Birmingham, London aims to become smart through digital systems. The S1 Smart Assessment shows that Birmingham's smart initiatives have delivered similar benefits to London's; both cities show a balanced portfolio of multiple impacts in the Society and Environment Lenses, with fewer in the Governance & Policy (Birmingham performing more strongly here) and Economy & Finance (London stronger here) Lenses. Both cities have also adopted similar timeframes for their initiatives. However, London has a better average star rating, which means its initiatives aim to have an impact on the population, while Birmingham's initiatives are better designed to deliver multiple benefits across the liveability assessment indicators.

Copenhagen's and Singapore's visions can also be considered to be contrasting. While Copenhagen has placed liveability at the core of the city vision and its smart focus, for this city, liveability is interpreted as being enabled by an environmentally and healthy context for living (i.e. a strong focus on the Environmental Lens). Singapore takes a strong top-down view on smartness that is highly dependent on the policies implemented by the government, with a much stronger focus on the Society Lens than the Environmental Lens. Here, citizens benefit from improved access to government systems, and at the same time, data collection (by the government) can lead to new polices and can help the economy – a symbiotic relationship. However, that does not deliver the broader spectrum of enhanced liveability for the wider Singaporean population. The S1 analysis shows that Copenhagen is the best-placed truly smart city; it has the highest number of overall initiatives, the highest number of active initiatives, and the highest average star rating (2.43). Singapore, in contrast, has the second highest number of initiatives, but its impacts on liveability are the least spread in terms of Goals of liveability impacts.

There are two potential conclusions to be drawn from this observation: there is a failure to think more broadly, when designing initiatives, that one of the primary considerations of any city initiative is people's current and future wellbeing – a notable finding of the analysis is that biodiversity, waste, food, and materials mostly sit outside the silo in which smartness is considered. Furthermore, the justification for investing in an initiative might fail explicitly to include the wider benefits of enhancing the smart agenda. Both of these conclusions are tentative because of the nature of reporting on initiatives (which often fails to provide the detail necessary for a full understanding of the 'business case'), and the fact that all initiatives have the potential to impact strongly on many, if not all, aspects of CityLIFE's Goals and Actions (however, the inadequacies of reporting impact the analysis here also). However, an explicit aspiration to enhance most, if not all, of the CityLIFE Actions when designing a smart initiative would increase the initiative's value and its attractiveness to investors (Rogers, 2018).

Strand One (S1 of the SMART) analysis has shown the first set of outcomes, which helps to inform the discussion on smart cities. As discussed earlier, Strand 2 of SMART (S2) incorporates local experts' opinions in a semi-structured interview process. Chapter 6 explores S2 in respect of Birmingham and London.

CHAPTER 6: STRAND TWO S2 CASE STUDY RECOMMENDATIONS FOR TRULY SMART CITIES

6.1 Introduction

SMART (S1) explored the initiatives in terms of delivering smartness though liveability Actions (as defined by CityLIFE), timescale, and their impact on a city's population, according to the star rating for each of the four cities. This showed that, in the UK context, London and Birmingham have seen a broadly similar number of benefits and have similar timescales for their initiatives. London has more initiatives that affect large interest groups in London. In S2, these two UK cities are further explored according to experts' opinions. Using semi-structured interviews, further evaluation of the smartness of each of these cities could be extracted to set priorities for future initiatives, and potentially refine the implementation of current initiatives.

6.2 Recommendations for Actions Needing Support From New Birmingham Initiatives

Birmingham's vision is focused on the development of the city to maximise the quality of living in the city, i.e. helping to develop and maintain long-term liveable conditions. S1 explored Birmingham's initiatives, the analysis of which showed that almost half of them are currently active and only a third of them are expected to benefit the whole population in Birmingham, as shown in Tables 6.1 (a and b).

Table 6.1 Star Rating of Birmingham's initiatives

Star Rating	**Initiatives Birmingham**	**Benefit (Direct + Indirect)**	**Total impact** (Multiplier Initiatives X star rating)
***	16	103	309
**	10	38	76
*	13	53	53
Total	**39**	**194**	**438**

Table 6.1 shows that there are 16 three-star initiatives, delivering the highest benefit. A detailed analysis of Table 6.1 can be found in Appendix H. There is perhaps the need for future initiatives to

have a greater emphasis on impacting on most of the population, and even those that affect sizeable (two-star or one-star) groups should be focused on and supported with relevant initiatives. This would benefit more of Birmingham's communities and potentially make the investment in the initiatives more cost effective, being able to deliver multiple benefits by a single initiative.

Currently, Birmingham's smart initiatives consist of significantly more actions that have an indirect impact rather than a direct impact. In general, a consideration of the total number of impacts (194) indicate there is need for future discussions, which focus on developing initiatives that provide a better distribution of benefits across the four liveability Goals. The initial analysis indicates that the Society Goal, in comparison to the other three Goals, is well served, with a higher degree of impacts, but this Goal could also see a benefit from designing for a spread of impacts when developing new initiatives. Thus, initiatives that relate to the community and individual well-being, especially via Actions related to healthy living and healthy, long lives and (in particular) minimising ill health, which has not been addressed, should be considered. Furthermore, due to the lack of initiatives impacting the Actions in the Equity Goal, it is recommended that new initiatives aim to improve the physical environment to maximise individual objectives in the context of carbon reduction and resource security, to enhance the social, economic, and governance and to minimise the impact of urban density on biodiversity.

However, the analysis showed that there was far less focus on, and therefore fundamental requirements to introduce initiatives to support, the Goals in the Environment Lens. Although Actions (in support of the Resource Efficiency Goal) increasing citizens' aspirations, resource-efficient living, and the match between well-being and minimising high-carbon mobility is supported, it is absolutely essential that particular consideration is paid to environmental initiatives that make advances in terms of water use, wastewater generation, food, waste, and recycling. These areas saw minimal or no direct benefits, and indirect benefits were also almost entirely absent. In order to support environmental Actions in working towards a smarter Birmingham, for example, initiatives should (in support of the Resource Security Action) maximise the sustainable use of low-carbon local energy, water, food, and materials before considering non-local sources.

In Economy & Finance, the CityLIFE Actions should also be more directly supported. For example, new initiatives should support economic vitality Goals, by uncoupling economic vitality from the CO_2 emissions associated with economic growth. In Policy & Governance too, more directly-targeted Actions should be developed to deliver a greater impact. Notably, the primary focus should be on initiatives that focus on uncoupling policy making and policy timescales from political cycles and the 'colour' of governing bodies, while additional initiatives that impact on uncoupling governance structures and timescales from political cycles and the 'colour' of governing bodies would help to support this Lens.

In general, therefore, the S1 analysis indicates that Birmingham would need to develop initiatives that have more of a direct impact on Actions that have been overlooked and that have an impact on the three Goals of Resource Security, Equity (fairness), and Resource Efficiency, for which the analysis showed an obvious lack of impacts.

6.2.1 Local Experts' Recommendations for Birmingham UK

In order to work towards a truly smart vision, Birmingham should consider implementing initiatives that affect the least impacted Actions in the CityLIFE framework, and especially those that impact the Environment Lens. Furthermore, when conceiving and designing new initiatives, the CityLIFE framework should be used as a touchstone to ensure that they will have direct and indirect impacts on liveability (distributed across the four Lenses). The semi-structured interviews were designed to reveal whether experts agree with the findings of the S1 analysis, and were also designed to reveal discussions with experts on the two smart exemplars (London and Birmingham), to find links between truly smart cities, and to provide potential urban living solutions to enrich Smart Birmingham/London. However, it should be noted that the interviews were conducted in parallel with the development of the SMART framework and the analysis of the cities, and therefore they are not in response to the S1 findings, but an independent set of views on the needs of Birmingham in relation to its ambition to be a smart city. The interviews were conducted with local experts (see Table 4.1) and their views are reported, and acknowledged as references, in the text below.

6.2.1.1 General

Liveability is essential when it comes to the smart city ideal, and yet current methodologies cannot clarify the meaning of smartness, so each stakeholder could have a different view of and opinion on, the topic (Participant 5). Participant 5 argues that various efficiencies gained from what we currently call 'smart' do benefit local authorities and public services; however, that happens purely in relation to thinking about economic benefits. While these could benefit people (and impact indirectly on the CityLIFE Actions) they do not aim to deliver liveability and sustainability primarily. Therefore, ideas about how resources are managed by a smart city should be drawn into the design and operation of Birmingham's activities, and the initiatives that support them; moreover, this should be viewed as both a challenge and an opportunity. For example, the rate of urban development (especially new housing) implies huge environmental pressure (Participant 3), and therefore adversely impacts on the natural environment and all that it provides for cities and citizens. Nevertheless, Participant 3 points out that this can provide opportunities to measure the impact on the resources for this development using digital technologies, and in this way, can lead to the generation of social and economic benefits via initiatives that react to the findings. It is widely reported that smart certainly benefits people, but possibly more important is that it can utilise technological advances in support of the delivery of a city's vision (Participant 1, Participant 2; Participant 4), and therefore policies should be designed to focus on city living that is explicitly for peoples' benefit (Participant 1, Participant 4), as well as having a clear aim in overcoming urban challenges (Participant 4).

6.2.1.2 Society

Societal benefits certainly stem from beneficial economic impacts that are generated in smart cities; this has been a clear overall benefit for Birmingham (Participant 3). However, the real challenge here is adopting a bottom-up approach (in addition to the top-down approach being adopted by the city) that can introduce more people to the benefits of being smart, and where everyone can gain the skills to harness these smart benefits (Participant 2). With this aim, a smart city should be a place where technology enhances fairness; unfortunately, that is not the case in Birmingham, as deprived areas are disconnected from wider technological advances. Therefore, it is essential that digital innovations

integrate urban areas that are currently divided and are not simply limited to achieving a few economic benefits for people in terms of their monthly bills (Participant 5).

Participant 5 further commented that smart solutions need not be economy focused; they should enhance liveability, questioning how digital connectivity (for example, a smart television) could improve lives in deprived areas, and we must make sure that the data collected by these technologies directs benefits back to the people. This could prove to be beneficial for the general population of Birmingham (Participant 4). Therefore, data collected should be used to benefit people and communities, not organisational bodies (as currently happens); that surely means that people and communities should gain from data operations, which could add to their benefits and potential (Participant 1).

6.2.1.3 Environment

Within the environment agenda, the link between smart and liveable cities was considered as the literature review shown; for example, low carbon practices are very likely not understood by the majority of people, but organisations profit substantially more from more efficient energy. Moreover, there are concerns where efficiency is concerned; on what the environmental impact of New Street train station is, for example (research done by the University of Birmingham at the New Street train station showed that nitrogen dioxide (NO_2) levels were higher than the suggested EU health limits (UoB, 2018). Furthermore, that data collection alone does not guarantee benefits for the environment (Participant 5).

People in smart cities, needless to say, need to reside in a liveable environment, where they should be able to interrelate with the environment (Participant 1). Smartness therefore has, or should have a connection to (environmental) sustainability and should be linked with low carbon emission practices, where technology assists in lowering emissions from both the built environment and mobility. Other cities have been successful in implementing this (Copenhagen, for example, as S1 showed), and there is no reason that it cannot happen in Birmingham. Relevant investment should therefore be in place (Participant 4).

Participant 3 notes that, despite the variety of opportunities in the environmental sector that can tackle Birmingham's environmental footprint, food is the most interesting because it breaks away from the silos of sectoral smartness (smart energy, smart transport, etc.) and can provide additional environmental benefits in many ways. This is most interesting, as food in particular has previously been implemented as a scheme (Food School, Harborne, 2015), and such schemes should be part of Smart(er) Birmingham. Birmingham actually implemented a good, clear view of what smart is, in the Smart Birmingham agenda; this comment has particular relevance given the lack of any apparent attention being paid to food in Birmingham's initiatives, as revealed by the S1 analysis.

6.2.1.4 Economy & Finance

A smart city has an imbalanced connection with the general economy of the city; it is inevitable that the value that derives from smartness is captured mostly by private entities and, often, there is no transparency when product development and profitability are involved (Participant 5). Cities themselves should be able to harness the knowledge that private organisations have gained from smart developments and practices, and then disseminate this to schools to enhance the employment skills of the whole population of the city; otherwise, the relationship is one-sided, where commercial companies support the notion that they adopt a 'clientele view' of these relationships (Participant 5). Participant 5, therefore comments that co-creation is vital when attempting to enhance the economy in smart cities, so that people can benefit too.

Despite the fact that economic benefits are not felt by everyone in a smart city, it has been pointed out that new technologies can lead to new economic paradigms (Uber, AirBnB) that can change the current relationship between company and client (Participant 3). Participant 4 is in favour of circular economy examples, because they can focus on local enterprises and provide additional (health, mobility, local economy) benefits. In Birmingham, such practices are encouraged, Participant 2 argues, because Birmingham's innovation centres have been experimenting with these ideas. Participant 1 underlines the need for openness and access to data, which would help capture the financial value of a smart(er) Birmingham, which, in spite of its best intentions, is moving quite slowly towards becoming open and data-ready.

It is very encouraging that iCentrum, a co-working space for smart city activities in Birmingham (also a BCC initiative), has been implementing digital technologies in new economic systems related to 'life sciences, mobility, and health' (Participant 4). Examples show, Participant 4 continues, that environmental practices further benefit the economy through low carbon practices, such as in the case of Copenhagen, where the smart city is in part conceptualised as a power centre, developing renewable energy; this should also be possible in Birmingham.

6.2.1.5 Policy & Governance

Smart in Birmingham is currently 'a work in progress', thus it is difficult to get much insight into how relationships are governed; smart developments can be a daring practice for all sectors involved, and cities are not empowered to understand and govern these sectors, so a disproportional distribution of benefits is likely to occur (Participant 5). Participant 5 underlines a democratic view for smart(er) Birmingham: a practice which can be consider radical, but essential for the local governance. He continues to suggest that it is important to adopt a more holistic approach to addressing Birmingham's challenges, which have always been infrastructural or environmental — this time, it should really be about delivering a holistic societal benefit.

Participant 4 disagrees: Birmingham is not quite smart yet. Liveability-focused decision-making is needed in the way that mobility is organised and, for example, in the way that the city faces the issue of obesity. These are two of the issues that BCC has not tackled successfully, yet they are fundamental to increasing liveability as a result of smartness. It would certainly help to have coherence between the different 'governance actors', which could combine thinking and actions, such as Birmingham's Green Commission and Birmingham's Smart Commission. Technology, Participant 4 notes, can help to achieve such coherence. Here, Participant 2 contribution focuses on how we can manage the abundance of data created, since if we compare, for example, Birmingham to Singapore, we notice a big advancement (for Singapore) in wireless technology, which could assist in city governance.

Overall, Participant 3 ideas are not far removed from what has been mentioned so far; they believe that the entire smart movement is driven by the market, and smart ideas become purely business plans, whereas cross-collaboration should be at the heart of a (truly) smart city's governance.

6.2.2 Local Experts' Recommendations for Advancing SMART (drawn from Birmingham interviews)

The discussions resulting from the interviews suggested the need for a city-wide spectrum of stakeholders in the smart agenda. These could offer alternative viewpoints in the S2 process of SMART and further the discussion about smart in the city.

Specifically, the governance of smart cities was considered as having a linear approach, which limits connections between stakeholders and can duplicate the existing silos that exist in BCC; to address this, a bottom-up approach that includes people's opinions is required (Participant 1). Participant 3 therefore suggests that, although the apparent stakeholders are BCC and the related commissions (Green & Smart), everyone needs to be part of what we call smart. This should enhance the engagement of less-represented communities in the 'tech industry', and this in turn requires visionary leadership. In addition to the obvious collaborators (BCC, private companies, and academic establishments), organisations such as Innovation Birmingham and those with a similar remit could enhance public participation. Most importantly, these organisations have to communicate their ideas, for example, the open sharing of smart practices between stakeholders and smart cities (Participant 4, 2015).

Major stakeholders, for example, big private entities, should pay attention down to the scale of the individual. In particular, these relationships need to be examined not in terms of 'implemented technology', but as an opportunity to reinforce this relationship on an equal basis. As such, smart cities should embrace people's participation (Participant 5).

6.2.3 Recommendations for a Truly Smart Birmingham

This section discusses recommended practices that result from the SMART evaluation for a truly smart Birmingham. A similar structure to that of the analysis carried out according to the CityLIFE Goals has been followed.

In Birmingham's smart agenda, 18 initiatives have been completed, while another 21 are continuing to deliver benefits. Any newly proposed initiatives should cover the Actions that this research has shown to not have been impacted on yet. These should be carefully conceived, planned, and designed to benefit as wide a range of Birmingham's citizens as possible; for example, including more two-star rated initiatives (affecting large groups in Birmingham) at the expense of one-star rated initiatives (affecting small sub-groups). However, following the advice of the experts, the primary emphasis should be placed on three-star initiatives, which can potentially affect the whole population of Birmingham. Specifically, according to the analysis, a smarter Birmingham must design the proposed initiatives to deliver multiple benefits as direct impacts, rather than with the hope that they might deliver unspecified indirect benefits. This would ensure not only that the far-future benefits of the initiatives are supported, for example, those expected to derive from urban developments and major mobility infrastructures but, importantly, that they provide immediate liveability benefits under the Societal, Environmental, Economic & Finance, and Policy & Governance Lenses.

As indicated in the overview (found in Appendix A.3), the Societal Lens has less impact, which suggests that fairness needs to be supported. This aligns well with the S2 analysis, since, according to the experts, new initiatives should enhance the role of the people and community in the smarter agenda and ensure that initiatives are associated with low carbon options in social, economic, and government practices – low-carbon living is for the benefit of all and might reduce, or remove, the need for direct or indirect taxation to enable the UK government to meet its legally-binding carbon targets (which, inevitably, disproportionately affect the poorer members of society. Technology and data sharing should also be considered a fair practice in smartness and its impact on the liveable realm.

It is crucial that the Environmental Lens is no longer, as it has been so far, overlooked in the smart agenda, or at least no longer siloed to another agenda (that of the Birmingham Green Commission). Smarter Birmingham needs to present initiatives that prioritise the use of local resources (energy, water, food, and materials). The water supply in Birmingham is unusual in 'local' terms, since its demand is considered as being met, as a result of the actions of Birmingham's forefathers, from

outside the city's boundaries - the City Corporation purchased land and constructed reservoirs in the Elan Valley in Wales, and water travels from there to the city by way of gravity. Interestingly, this was done due to population increase demands and the requirement for sanitation (Chamberlain, 1892). Although ownership of water companies is now in private hands and it might not be seen to be the city's responsibility to intervene, or perhaps as being beyond the power of the city to intervene effectively, a sustainable source of water for local provision can be argued to have been provided. One should not fail to consider, however, the numerous Birmingham canals (NCBA, 2017), which has the potential to become a significant contributor to personal wellbeing, and the meeting of carbon and energy budgets, and could contribute to local governance through collaboration opportunities, for example, those presented by the Future Cities Catapult, which facilitates opportunities for city services in support of the local economy (FCC, 2018). Birmingham should claim responsibility for taking action and apply forward thinking to take advantage of its waterways and connect the benefits derived from city's actions. Food also has huge potential to support interdependent practices and provide opportunities for lowering carbon emissions as part of a wider agenda linking various actions designed to achieve lower CO_2 emissions.

Food initiatives could also benefit Economy & Finance Actions and set an example for how initiatives can directly impact more than one Goal. The benefits of lowering CO_2 emissions are not only seen as environmental impacts, but could also impact on the economy of a smarter Birmingham, providing knowledge and examples for further innovative solutions that could change the provider-client approach and potentially lead to a more circular economy. Such practices can be implemented within the existing co-working spaces in Birmingham, where practices (initiatives and smart city examples) can be shared.

Although few initiatives impacted the Policy & Governance Lens, and the subsequent analysis via S2 showed that, evidently, few initiatives concerning governance and policy are needed, as has been done with Smart Birmingham, where the identification of system interdependencies is likely to redirect a top-down approach to a non-silo, bottom-up approach. Such action would also support open and shared city data, as well as supporting the local creation of initiatives.

These suggestions could be further considered by a group of local experts, perhaps in the form of a senior thought-leadership group representing all of the major stakeholders, in an effort to prioritise the need to have an impact on the liveability Actions identified above. However, as discussed in the interviews, visionaries from BCC and affiliated organisations should embrace the benefits of a bottom-up approach, alongside their thought leadership, as suggested in this thesis as an addition to SMART (i.e. S2 to complement the S1 analysis).

6.3 Recommendations for Actions Needing Support From New London Initiatives

London's vision is founded on the collaboration of regional organisations and London boroughs, and it has declared its ambition to be an outward-looking, open city. London's smart initiatives consist of a combination of previous and current local governance (i.e. advocated by the previous and current Mayors of London), and as shown in Table 6.2, the majority of the initiatives have a two-star rating (Table 6.2). This means that initiatives benefit medium-sized groups in London, which are considered to be business or technology-related groups. However, the star ratings show that only one third of the 46 initiatives benefit the whole of London's population (Table 6.2).

Table 6.2 Star rating of London's initiatives

Star Rating	**Initiatives London**	**Benefit (Direct + Indirect)**	**Total impact** (Multiplier Initiatives X star rating)
***	16	86	258
**	19	54	108
*	11	53	53
Total	**46**	**193**	**419**

London has seven more initiatives than Birmingham. While this might be expected, due to the metropolitan size of London, one would also expect that city-wide impacts would be a priority for the adopted initiatives; here, this is clearly not the case. One of the main differences between the two cities is that London's initiatives have almost equal benefits in terms of direct and indirect impacts, in contrast to Birmingham's concentration on indirect impacts; the total number of impacts was found to be 193, which are approximately evenly distributed between direct and indirect impacts.

The London overview shows that there are slightly more direct impacts in the Economy & Finance and Policy & Governance Lenses. However, most of the other actions have similar amounts of benefits and their distribution is not dissimilar to that of Birmingham. For example, the Society Lens has a similar distribution to Birmingham, with the greatest focus being on 'maximizing the physical environment to maximise individual capabilities in the context of low carbon reduction and resource security'.

The biggest difference between Birmingham and London is shown in increasing awareness in environmental and climate change issues (where London has four more direct impacts and one indirect impact), highlighting an area in which new initiatives could be introduced in Birmingham. Also both for London and Birmingham, there is a lack of initiatives impacting the Actions in the Environment Lens, especially ensuring resource security. London saw some impact in the 'increasing awareness of, and interest in, environmental and climate change' Action and also in 'increasing the match between city dwellers' aspirations and resource secure living', yet both Actions were impacted less than in Birmingham. London's initiatives' show a lack of impact on resource security – a low (direct and indirect) impact overall – meaning that the use of local water, food, and materials is not reflected in any of London's initiatives (as was also seen in Birmingham). Furthermore, London's ambition to be an open city shows also zero impact on the specific considerations of local people; the opposite is reflected in Birmingham.

London's initiatives have impacted on the Economy & Finance Lens considerably more than Birmingham's, with many of London's initiatives having positive impacts (directly or indirectly). Here, suggested initiatives could maximise investment to better support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO_2 emissions) and (with more direct impacts) uncoupling economic vitality from the CO_2 emissions associated with economic growth. In comparison to Birmingham, London has ten more impacts in support of liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO_2 emissions).

Although one would expect that Policy & Governance Actions would have an increased benefit for London, being the UK's capital city, that is not the case. London's initiatives have 13 fewer impacts

for ‘uncoupling governance structures and timescales from political cycles and ‘colour’ of governing bodies’ and three fewer for ‘uncoupling policy making timescales from political cycles and colour governing structures’. Both Actions should be supported by new initiatives, especially direct impacts on ‘uncoupling policy making and policy timescales from political cycles and ‘colour’ of governing bodies’ – indeed, London being the capital might be the reason behind the zero carbon direct impact.

As shown in Appendix E (which presents a comparison of the four case studies), the overall benefit (direct/indirect) from supporting the liveability Actions is less (by one impact) in London. Therefore, the liveability assessment for the two UK cities has shown that, despite the size of London as the biggest city in the UK, size is not a defining factor in the development of a truly smart city.

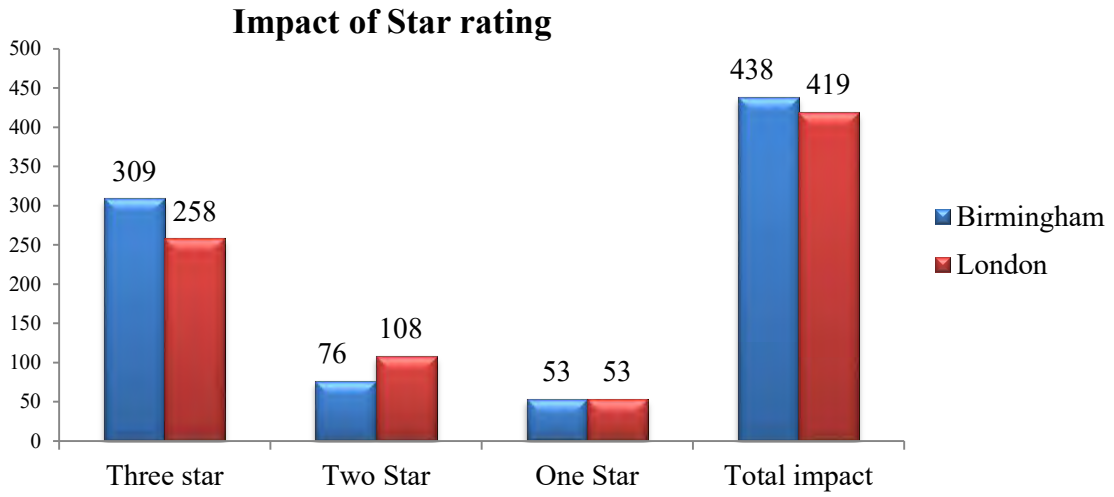

Figure 6.1: Impact of star rating for Birmingham and London

In addition to this statement, and according to the overall star rating of the initiatives’ impact on the population, Birmingham shows the most advancement: the overall sum of the star ratings is 438 points, in comparison to 419 for London. This shows that Birmingham has more groups affected by the smart initiatives; therefore a larger portion of the population is affected. Here, one should consider additional examples, e.g. the case of Copenhagen, a considerably smaller area, yet having ten more initiatives than Birmingham and London, and having a higher total star rating (572 points).

Despite these comparisons, according to the liveability overview, London has a low number of impacts in respect of resource security and efficiency, equity (fairness), and appropriate policy Goals.

Initiatives that impact the Actions in these areas need to be discussed and prioritised as part of smarter London.

6.3.1 Local Experts' Recommendations for London, UK

London's true smartness can be enhanced to benefit Actions related to liveability, especially those in the Environment and Policy & Governance Lenses. This section discusses the experts' opinions, captured in semi-structured interviews that took place in London.

6.3.1.1 General

Although there are specific individuals who are leading important smart actions in London (Participant 9), the idea of smartness depends on the context in which the various urban concepts that develop the discourse are to operate and how they will benefit people in cities (Participant 6). Smartness is not a specific term, and most embrace smart as the use of digital technology in general (Participant 8). Specifically, the smart agenda started as a top-down approach, and it has shifted, with the use of technology, into an overarching agenda that enables citizens to engage (using data systems) with the governance systems of cities in an open and efficient way (Participant 7). The true benefits of smart come from these digital interventions and can also have an effect on people on an individual level (Participant 6).

6.3.1.2 Society

There are examples that have enhanced the social value of smart cities; for example, in mobility, transport apps offer a better experience to travellers, as well as creating datasets that can benefit society in economic terms (published transport data, TfL, 2016) and in terms of sustainability, and can inform future infrastructure solutions (Participant 7). It seems that Participant 9 opposes this idea, as they believe that smartness presents societal challenges; for example, to be smart requires individuals to be connected to a digital system – 'not everyone is part of it' and this creates additional inequalities (to the existing inequalities), on a digital level.

In terms of urban scale, however, London requires such overarching solutions and needs to provide radical solutions to climate challenges and reduce the adverse impacts on the city and its people (Participant 8). Attention should be paid to underprivileged areas in London (also the case for

Birmingham) and more initiatives should focus on them. The FCC is currently developing projects that could improve city living, and for this, digital technology is crucial (Participant 6). London should be considered a unique smart place, but for this to happen the extreme residential and mobility challenges, and other more general issues, which the city faces need attention (Participant 8).

6.3.1.3 Environment

London's climatic challenges could be tackled with the use of digital technology. Therefore, Smart London should reflect a city that is becoming more efficient. Nevertheless, one should appreciate which solutions are truly useful, liveable, and enhance London's efficiency (Participant 8). Participant 8 refers to traffic, air, and mobility management which are able measure current environmental qualities and predict future patterns. Improvements to such systems, and also to citizens' health and well-being, are being developed by organisations (e.g. Arup's London Office), and these also include considerations for water and waste systems in the Environment Lens (Participant 7). Measuring environmental qualities, however, requires the collection and management of real-time data, which challenges personal information and the whole societal idea and freedoms in smart cities; Participant 9 is sceptical about inducing people's activity (as this would provide real-time data) in the city. However, not using individual information for the wider benefit of society could be also considered unethical, because the opportunity to grasp environmental data would be lost (Participant 7). Therefore, solutions such as that seem legitimate, especially in the context of London, which faces many environmental challenges. In this respect, Participant 9 suggests that, in London, projects that use real-time data are seen as business proposals, whereas, in reality, smartness needs to address concerns relating to the social issues connected with these solutions.

6.3.1.4 Economy & Finance

Evidently, says Participant 6, private organisations implement solutions that are highly dependent on digitalisation, and that support data collection, since this is also perceived to be the essence of being smart; however, it is a different case for individuals, as they only receive a service, and is also different for local authorities, since they are responsible for considering the overall liveability agenda. For this, a focus on ecosystems has been implemented; for example, Arup collaborates with

universities and other businesses to develop solutions that deliver mutual benefits (Participant 7). Innovative solutions need to be in place that are not only based on efficiency or profit, but that are context-based solutions that consider social issues and include educational approaches in the new systems - this is already happening in the FCC (Participant 6). However, the commercial realm is a strong enabler for London; there is the market demand for such liveability solutions or specific technologies, and businesses respond to the business environment. The benefits of this could reach local governance and involve engagement with the public (Participant 7).

For Participant 9, economy has a different role in the smart agenda; it provides benefits to those who already benefit from smart solutions and can afford to invest in new ones. Furthermore, he believes that, in reality, the financial approach to smart does not encourage the co-creation of new ideas, but creates a promotional business environment. In contrast, innovation in smart cities needs to be supported by decision-making; the way that we design cities to enhance human contact that leads to the communication of ideas, not ideas that simply generate profit for a small group or commercial organisations. The focus should be on how we can support people who, so far, have not achieved or developed economically viable solutions (Participant 9).

6.3.1.5 Policy & Governance

Initially, smartness took an '*organic*' approach, where the people involved came up with ideas that used technology to improve city living. Currently, there are only a few initiatives that can really deliver liveability in London – and these are developed by the GLA (Participant 9). It is important how initiatives are organised, Participant 9 notes. We currently face a '*smart chaos*' when it comes to the governance of smart cities; we have yet to understand the interdependencies of the smart(er) city; we ought to be educated on the organisational requirements of the smarter city in order to develop much needed decision-making in the smart(er) cities process for (Participant 6). Interesting approaches have been taken in London's Spacehive, a place where citizens can crowd-source projects. However, it is the bigger organisations that play the major roles in governance – the London boroughs, the Greater London Authority, Thames Water – and they should all engage citizens in many ways, that is, adopt a two-way approach, which means that citizens should also be willing to actively

take part (Participant 7). Participant 7 mentions Singapore as a smart city that, because its leadership doubles as the National Government, has effectively implemented smart systems; surely, this might not be the best example (because of its uniqueness as a city state), but such an agenda can encourage collaboration. Therefore, a holistic approach in governance could provide benefits for everyone. Governance is not necessarily only for smart initiatives; for example, the Crossrail project is of high importance, but it cannot be described as just smart – the project is a big undertaking in London and could have a positive liveability impact on its inhabitants (Participant 9). Participant 9 also comments that liveable solutions drive people to have an input in decision making, which, in the case of Birmingham, has resulted in many businesses and individuals relocating to the city due to the local economy in the capital. It is also important to understand the stakeholders involved, the different national authorities that can be involved (health, transport, and local), and the ways that they can work together (Participant 6).

6.3.2 Local Experts' Recommendations for Advancing SMART (drawn from London interviews)

There are initiatives being developed by the GLA that could prove to be good in terms of (true) smartness (Participant 9). However, there is a hierarchy of stakeholders (local, mobility, and health) that should be involved in the smart city realm. Of course, people and the wider community should be too. Currently, many at a lower-level are not engaged, but they should be at the centre of who we consider to be participants (Participant 6). Experts are context-dependent, although local authorities (LA) always take the main expert role; also involved are smaller agencies (London Datastore, Talking Shop) that are also part of the LA, and also smart city co-working spaces and, of course, local universities (Participant 8).

Smart London seems to focus on the collaboration of organisations within the smart ideal – how these could work together – and this introduces the idea of the interdependencies that could benefit individual and communities in the city. Section 6.3.3 recommends practices resulting from using the SMART assessment, considering the liveability Actions affected.

6.3.3 Recommendations for a Truly Smart London

This section, so far discussed the liveability assessment (as well as the timescale and the star rating) of the smart initiatives and the experts' opinions. This recommendations section is looking at the areas (Actions) that could benefit further according to the analysis of the initiatives and the experts' opinions.

Specifically, although there is (compared to Birmingham) a larger number of initiatives (25 active), these seem to do not impact all of the actions that support liveability. Currently, the majority of the impact is seen on large groups in the city and, to a lesser degree, the whole population of London. Less benefits are seen by small, specific groups in the city; a fact that is encouraging. However, because of the large population of London, the liveability benefits of being truly smart should reach the majority of, if not all of, the population of London. A truly smarter London needs to consider its focus on being open and how the proposed initiatives might impact on that vision.

Looking at the overview analysis for London for London, new initiatives should enhance liveability Actions. Society Actions have generally been strongly supported, however, new initiatives should be proposed to ensure equity (fairness) and to 'minimise the impact of urban density on biodiversity'. However, in the Environment Lens, it is crucial that smart initiatives support resource security Actions. In particular, these initiatives need to focus on 'maximising the sustainable use of local water first and then maximise the security of supply of non-local water'; a similar requirement exists in the cases of local food, materials, and people. However, as mentioned previously, the Action of prioritising local people might come into conflict with London's idea of being open. Additional consideration is needed in this case. As discussed with the experts, London has focused its environmental priorities on developing business solutions; therefore, there is a strong case for an environmental strategy to shift the overarching focus on to liveability and not just finance. This might be considered a high priority, as the discussions reveal the urgency of London's environmental conditions.

The Economy & Finance Lens rightly shows a strong impact on the Actions. This is primarily concentrated on large organisations in the capital, and results from London's vision for openness,

which attracts opportunity and, therefore, human resources. As discussed (in Section 2.3.1.1), current smart solutions so far, mostly respond to market needs, where these have created opportunities to respond to London's challenges. Furthermore, large private organisations are able to generate investment for such projects (and initiatives) and are able to foster collaborations with universities and local authorities, and even spin off other companies under their remittance. It seems, therefore, that London benefits from the governance of such dependencies.

However, this is not the same when it comes to the Policy & Governance Lens. One would expect that, due to available access to the country's main governance structures, there would be considerable support for liveability Actions, possibly as it is in the Smart Nation of Singapore. As the overall analysis shows, however, initiatives directed at this Lens should target uncoupling governance structures (and especially policy timescales) from political cycles and 'colour' of governing bodies to ensure appropriate governance (and appropriate policies). Here, discussions show that, although there is an abundance of local authorities that could collaborate, there is a need to organise practices in a human perspective and to consider a central role for people.

Overall, Smart London could be considered to be on a good path when it comes to the balance of benefits: direct and indirect impacts support the liveability actions by an approximately similar amount. It is, however, advisable that new initiatives focus on benefits for all of London's population, ensuring liveability for all.

6.4 SMART compared with Existing Tools

Following the evaluation of tools (in Chapter 3) and the SMART development (Chapter 4), this section summarises the points of comparison between the existing tools and the proposed SMART. It is argued here that the SMART, compared to the structure, outputs and overall value of the existing tools, provides positive and novel developments in smart city assessment. An example for comparison is the Smart City Network Model (SCNM) described in Section 3.2.1.1, which is presented here due to similarities in the general approach used in the SMART. These include the fact that the SCNM is an academically-developed tool for smartness which considers liveability as one of the city visions. However, although the SCNM offers the possibility of a pairwise comparison of a smart solution,

liveability is not considered central in the assessment of smart, whereas the SMART embeds liveability qualities of smartness throughout its analysis and considers it across population scales using the three star assessments, which shows the liveability effects on smartness (i.e. via likely direct and indirect beneficial impacts) for three different population groups. This is a valuable addition to the existing tools, since it is able to clarify population disparities that smartness creates, a statement that can be equally made in relation to other existing tools.

The smart categorisation that the SCNM suggests (i.e. smart governance, smart economy) provides little clarity to what is meant by smart and how these are assessed. Even though the SCNM creates a matrix system connecting the smart categorisation in sectors (University-Government-Civil Society-Industry), i.e. it indicates under which smart category a smart project (or initiative) would sit, it lacks the necessary assessment criteria to provide clarity on the likely impact of a project and issues to be raised in high-level discussions; it therefore fails to adequately inform further implementation of smart initiatives. In contrast, the SMART provides four lenses as part of its 'categorisation', each of which include assessment criteria; the lenses indicate the main focus of the proposed solutions. Within each lens, there are clear criteria, listed in a vertical way, providing a self-explanatory way to assess any smart initiative.

The second strong candidate might be argued to be the SPeAR® approach. Although it has been developed as a visual method to explore the sustainability of projects, and how alternative designs could enhance the sustainability, the general principle could be adopted to attempt to achieve an assessment of liveability. However, if this were to be used, the design of the segments would need to be changed and, unless the Actions were to be amalgamated, there would be many segments that would need to be referenced to a separate list. Shading could be applied, with dark and light colours to represent direct and indirect benefits, perhaps with six concentric rings to demonstrate the reach, but the complexity would be too great to make the system workable, while amalgamation would preclude the direct and indirect benefit analysis to be shown since each Action within an amalgamated segment might have a different reach (hence three-star rating). In short, it would lose its effectiveness.

In spite of the above arguments, the greatest claim to the efficacy of SMART lies with providing an open, transparent, and transferable formula for the smart assessment. This is seen through two instances: the open process reported in this thesis, i.e. a framework for a detailed analysis drawn from published documents and open for the wider public to contribute or judge (Strand 1), and the ability to include enriching discussion embedded in Strand 2 of the methodology of the SMART. In other words, the evaluation for truly smart cities is completed in two strands—one dealing with publicly-available documents and the second providing the opportunity for local experts to discuss and prioritise the smart initiatives, according to the local needs of the city and people. Importantly, this dialogue, once started, can lead to the co-creation of new or enhanced initiatives to move the city further forwards in (true) smartness. Moreover, as discussed in the methodology, the SMART allows for additions (such as Cost Benefit Analysis) and expansion in local participation. In this way, the SMART establishes its resilient characteristics, because it takes into consideration the changes in time and the necessity to adapt to future challenges, as also described in the Urban Futures and Aspirational Futures methodologies (Lombardi 2012 *et. al*; Hunt and Rogers 2014; Rogers *et al*., 2014b; Rogers and Hunt, 2019). These futures analyses, when added to SMART and applied to the context of the city in question, enables the initiatives to be assessed in this future city context.

For these reasons, the SMART has developed a more robust and self-explanatory structure, with clear and open outputs that can be discussed with experts, while the additional value of this new tool would lie in its ability to guide the development of future smart initiatives and/or the adaptation of existing smart initiatives to address future challenges and opportunities so that the city moves further towards true smartness. Therefore, the research contends that the SMART offers a novel and important contribution to the wider smart cities research landscape.

6.5 Conclusions

Birmingham and London have been discussed according to Strand 2 (S2) of SMART. The documents that detail the smart initiatives in these two cities have been analysed and discussions (in the form of semi-structured interviews) took place to explore the smart priorities of the two cities. Further recommendations were made for both cities. A comparison of the two cities, taking the SMART

analysis into consideration can be used to draw further conclusions. Due to the size of London and its proximity to the central government, it was expected that the number, impact, and star rating of smart initiatives would be considerably higher in London than Birmingham. However, Birmingham seems to be considerably smarter in comparison to London. As revealed by the experts' opinions, both cities lack initiatives that benefit (both directly and indirectly) Actions in the Environmental Lens. Similarly, both cities should consider initiatives to ensure equity (fairness), as it has also been noted by the experts that an inclusive societal view of initiatives is important in truly smart cities. Interestingly, so far, Birmingham has more indirect impacts from its smart initiatives. One, perhaps fundamental, difference is that Birmingham has supported the 'maximise the sustainable use of local people first (e.g., utilising the local workforce and leveraging local skills) and then maximise the security of supply of non-local people' Action, whereas London, due to its open vision, does not appear to consider this important. A truly smart city (here, Birmingham or London) should propose holistic, integrated initiatives and take into consideration the influence that interdependencies can have on the impacts of initiatives on each Action, with the aim of maximising the impact on people (both in terms of the significance of the impact and its reach) and in relation to the timescales (with durable impacts being better).

CHAPTER 7: DISCUSSION OF RESEARCH FINDINGS & FURTHER RECOMMENDATIONS

7.1 Introduction

This thesis argues that liveability is an essential component of a smart city and that truly smart cities are those that support liveability. Accordingly, this research has explored smartness through the lens of individual and societal well-being. The aim of this research has been to understand what is meant by the concept of 'truly smart' and to explore how liveability can be assessed in smart cities. For this reason, the main objective of the research has been to develop SMART to assess liveability in smart cities and prove its efficacy in four case studies. The four selected cities (Birmingham, London, Copenhagen, and Singapore) were assessed on the initiatives developed as part of their smart agenda, evaluated in terms of liveability, reach (timeframe), and population impact (star rating).

In more specific terms, SMART has been developed as a two-strand (S1 and S2) approach to support decision-making by assessing (smart) initiatives and making recommendations to support the refinement of existing, and the development of new, initiatives to achieve truly smart cities. The S1 process showed that Copenhagen is the most successful truly smart city, whereas the least is Singapore. Furthermore, the S2 analysis for both Birmingham and London showed similarities with regard to their attention to liveability in smartness. Yet, while Birmingham has introduced a uniformly high level of liveability in its smart agenda, London's expectations have been shaped by its size, proximity to government fund sources, and other factors, due to being the capital city. This chapter discusses the implications of the research findings in terms of benefits, limitations, and further suggested research.

7.2 Summary of Research Findings

Overall, the research can be summarised in the following:

> *This research developed and applied SMART to assess the (existing and proposed) initiatives in the smart agenda in order to inform decision-making for truly (liveable) smart cities (here, using four case studies).*

Early on, it became apparent that the meaning of 'smart' is unclear; and smart city agendas overlapped and even contradicted each other (Cavada *et al.*, 2014). For this reason, this thesis has included an extensive literature review, in which 'smart' was explored using a thematic city approach to understand the meaning of the smart city. Four exemplars of smart cities – analysed through their vision, initiatives, and funding - were studied in detail. Lastly, the available tools for assessing smart cities were reviewed. It was concluded that 'smart' is a city theme that spans various subjects (smart and also other thematic city approaches) and can differ according to academic, commercial, or governance visions of smartness and the intentions of the initiators of smart city initiatives'. Similar ambiguity is shown in the smart city exemplars where, according to their vision and city resources, smart cities can differ significantly in terms of delivering smartness. The 'Smart City Matrix (SCM)' provides evidence of the various ways in which smartness is conceived and shows the complexity of defining smart – a clearer understanding of smartness would lead to a shared smart agenda (Cavada *et al.*, 2014), and this should in turn lead to true smartness.

7.2.1 Unclear Definitions and Political Cycles

It has been suggested that, to address rapid urbanization and the other challenges that affect current city living and future living, fast developing technology should be able to solve problems and to potentially enable city living and city expansion that proves to unharmful, but beneficial in the widest sense, to humans (Liveable Cities, 2013). Truly smart cities require solutions to problems such as pollution, illness, crime, and others in an independent way – to provide solutions to a range of city challenges. To be able to do this, we need to be able to assess the liveability of cities and their interdependencies (Bouch and Rogers, 2017). A mainstream agenda of digital embedded solutions should be aware of the implications for individuals and, more generally, society. Therefore, a more rounded ideology that can assess the liveability of these implementations, referring to the societal, environmental, governance, and economic perspectives of smartness affecting both individuals and society as a whole in the urban context (Leach, 2017b), is needed. Current criticism is directed at commercial organisations, because the services that they offer as smart are too often simply focussed on resource optimisation and it is unclear how they provide benefits to people; however, using their own data (i.e. individual personal data), they are in a position to have valuable insights into how to

provide wider benefits (Participant 5). Betterment of life should be at the centre of smart city thinking, as we need to establish liveability actions for truly smart cities and ensure benefits for both individuals and the wider community, both today and in the future, to ensure liveability in smart cities. The assessment models showed some similarities in how smart is assessed, and yet there was no strong indication of a liveability assessment for truly smart cities. In Chapter 3, the critical appraisal of the tools explored in the literature showed that CityLIFE is the most appropriate tool to assess liveability, and this has accordingly been incorporated in SMART. In Chapter 4, SMART was developed to assess the liveability of smart cities, where the assessment is based on the smart initiatives developed by a city, and this was illustrated by exploring the smart initiatives in four cities. However, smart initiatives and, therefore, smart agendas are particularly influenced by political cycles and 'colour' of the governance in cities. It is consequently understood that these initiatives typically align with a particular philosophy of governance while intending to provide solutions within the smart agenda and deliver truly smart benefits that might change in the future. The change in governance of London is a good example. On 11th June 2018, London unveiled its updated smart agenda under the new Labour Mayor (MoL, 2018). Some of the changes were indicated in Chapter 5, where a number of initiatives in London were characterised as 'completed' for the purposes of this research, since they were initiated by the previous Mayor of London under a Conservative philosophy of local governance.

7.2.1.1 Smart London Plan

The smart agenda for London has been shifting between a series of smart visions and updated standards for smart cities (BIS 2017, 2018a and b). London published the latest 'Smarter London Together' (GLA, 2018), a smart plan led by the newly-created post of London Chief Digital Officer (CDO), which aims to make London the 'highest in smartness' city internationally. The latest smart agenda (GLA, 2018) has been issued by the recently-elected mayor, Sadiq Khan, who represents the Labour party during a time in which the UK has a Conservative national government. The latest smart agenda made steps towards creating conversations with citizens and acknowledged that policies (and the smart agenda) could affect, and be affected by, post-Brexit relationships. Prior to this, 'The Future of Smart' (GLA, 2016) was a revision plan that envisioned the capital as an internationally

acknowledged smart city; this was issued under Boris Johnson (the Conservative mayor at a time when there was a Conservative-Liberal Democrat coalition UK government). Initially, the 'Smart London Plan' (GLA, 2013), also issued by Johnson at a time he was the mayor, focused on digital technologies and digital innovation to positively affect citizens' lives. In addition, the Singapore case study showed that a government-led smart agenda (Smart Nation Singapore) could have benefits in terms of implementation and access to funding for smart initiatives. However, the outcomes from these top-down, government-led smart initiatives showed that this kind of governance vision might not meet citizens' aspirations or deliver a holistic view of liveability.

Therefore, even though these initiatives were intended to shape the smart agenda in order to deliver benefits for the distant future, political agendas influence the continuity of the smart vision, or even enhance it, with novel notions for smartness (and smart initiatives); as such, smart is a process – especially in London. This thesis proposes that a truly smart vision should be directed towards a city's smart liveability goals, and that vision – and the initiatives adopted to deliver it – should be capable of being assessed as being truly smart in a transparent way at any point in time. It is also prudent to examine whether targets set by wider agendas are affected by smart cities, and to examine the support for liveability Goals through both direct and indirect impacts by all city and national agendas to ensure that liveability is embedded in distant-future strategies.

7.2.2 SMART Benefits

A critical analysis of the existing tools for assessing smart cities provided a partial view of liveability, as explored in Chapter 3. Among the tools discussed, there is evidence of some themes relating to liveability; for example, SPeAR® examines sustainability, the ANP method sees liveability as one of the alternatives to the smart city theme, and the others examined show elements of liveability incorporated in their assessment (McGregor and Roberts, 2003; Lombardi, 2011; Arup, 2013). The CityLIFE tool is the only tool that explicitly assesses liveability, and for this reason, it has been used as the main approach in the development of SMART, which specifically aims to provide clarity via a transparent assessment, to be used by city leaders and national and local policy-makers, when exploring the liveability benefits for the initiatives they adopt (Leach, 2016). SMART, as explained in Chapter 4, assesses initiatives in two strands: S1 assesses smart city initiatives on the basis of city

agenda documentation to determine whether they support the CityLIFE Goals; and S2 incorporates the added richness deriving from local experts' opinions.

Additional prioritisations include the assessment of the initiatives' intended timescales, the experience of the cities' population (Reach) and the impact of the benefits delivered on the cities' population (star rating). At a high level, liveability benefits can be judged in terms of whether smartness is balanced (across the four liveability Lenses). The research has shown this can be achieved by following a process of document analysis using SMART (S1), confirmed and embellished by the added richness of discussion with experts (S2). Further additions here could also include citizens' aspirations, to ensure that benefits can be delivered in a socially-acceptable form to a wider population of the smart city.

7.2.3 Comparison of smart initiatives to liveability metrics

Liveability correlates with sustainability in that it aims for the betterment of living quality, with a particular focus on social and environmental factors. Liveability indicators will inevitably bridge over the two areas, therefore (Antognelli and Vizzari, 2015; Leach, *et al.,* 2017c). However, liveability takes a more citizen-centred view of city living and attempts to address the balance away from an analysis that all too often considers the social pillar as related to society as a cohesive whole. As with the term 'smart', which is a contested concept and has been analysed by the author in terms of definitions and measures (Cavada *et al*., 2014), liveability is likewise interpreted in many different ways with many different metrics, and it is for this reason that Liveable Cities embarked on a study of different definitions and metrics and created a bespoke set of liveability performance parameters (Leach *et al*., 2017; Cavada *et al*., 2017). The degree of overlap between indicators depends largely on the purpose for which the various liveability indices were created, and yet, as has been stated previously, none address the issue as comprehensively as those embedded in CityLIFE.

There should be an analytical, or assessment, approach that explores the synergies of liveability indicators with current policies and how they influence and help shape new ones. From a policy perspective, liveability indicators need to be included and/or adjusted within the structures of policy-making, for example planning legislation and environmental policies (Antognelli and Vizzari,

2015). When engaging in the process of translating liveability framework(s) to policy, Villanueva *et al.* (2015), indicated certain challenges, for example spatial boundaries, datasets challenges, and the interdependencies between them. Currently one can only make assumptions about the timeframes for implementation or changes that affect their future performance.

This research early on established that liveability needs to be at the centre of what is discussed in smart cities, and introduced at the very start of the conversation. It adopted the CityLIFE methodology, a liveability assessment framework, in the development of the SMART so that judgements can be made on whether initiatives advance a city towards what has been called in this research true smartness. It is provided to enable liveability assessment to be made in practice and has been demonstrated in the four case study cities included in this thesis. .The SMART offers multiple opportunities for crossover between liveability and policy-making: first and foremost it was used to assess published (typically policy-led) smart initiatives in terms of liveability; second it categorised a timescale for the benefits delivery of initiatives (allowing policy interventions to improve benefits delivery); and third, it was used to identify and make transparent the additional benefits (i.e. the indirect benefits that extend beyond the intended benefits) and place both direct and indirect benefits on a scale that reflects the proportion of a city's population that is beneficially affected, using a three star rating. This means that this new understanding of true smartness can and should be used to affect decision-making and policy-making, while at the same time making explicit how (true) smartness is, or has the potential to be, enhanced by existing initiatives for the betterment of city living. This is further discussed in the next section in terms of the outcomes of the four cities' SMART assessment.

7.2.3 Comparison of Four Smart Cities (the Case Studies)

Chapter 5 explored four smart cities (Birmingham, London, Copenhagen, and Singapore). All four were assessed using the S1 of SMART and the two UK contexts were explored in additional detail using both S1 and S2 of SMART. The benefits are summarised here.

7.2.3.1 Strand One S1 - Birmingham, London, Copenhagen, and Singapore

Smartness is an ongoing process and this research has shown that further initiatives need to be implemented that will affect more liveability Actions in order to broaden the smart agenda of the city,

since some Actions are not supported or are poorly supported. The SMART S1 process showed significant omissions in the smart visions that the cities created, which the cities could incorporate to become (more) truly smart. More specifically, it provided a more holistic overview for each city assessed one that is missing from current smart city rankings and assessment methods.

Birmingham's vision has been focussed on development with long-term living quality goals, as demonstrated in the Eastern Corridor Smart Demonstrator and Innovation Birmingham initiatives (BCC, 2017c; BCC, 2008). The S1 SMART assessment for Birmingham identified the lowest number of adopted initiatives (39 in total) of the four cities and also the lowest number of active initiatives (20). These have been judged to deliver a total of 194 impacts on liveability actions – 75 direct and 119 indirect – with a star rating of 438. Benefits have been delivered in terms of the Society (74), Environment (66), Economy & Finance (23), and Governance & Policy Lenses (31). Although the Environment Lens is a big part of the CityLIFE assessment, here, only a few initiatives have some impact on Actions (66), some initiatives indirect impact Actions (10) were delivered to maximise the sustainable use of local people first (e.g., utilising the local workforce and leveraging local skills) and then to maximise the security of supply of non-local people to maximise cultural services (in ensuring resource efficiency).

London's vision has focussed on looking outwards to become an internationally renowned smart city with priorities of mobility, environment, commerce, housing, and youth (GLA, 2018c; MoL, 2017a, c, GLA, 2018e, d). This case study showed that, from 46 initiatives (with 25 active initiatives), there were 193 impacts; of these, 95 were direct and 98 were indirect impacts. Most of those were in the Society Lens (71), followed by the Environment (61), the Economy & Finance (46), and the Governance & Policy Lenses (15). An important environmental contribution concerns support for increasing the match between city dwellers' aspirations and resource secure living Action— 15 impacts. London's initiatives have a star rating of 419. Interestingly, in the Governance & Policy Lens, fewer benefits were delivered in comparison to Birmingham. Also, the star rating shows that London's benefits affect a wider proportion of the population in comparison to Birmingham.

Copenhagen is evidently primarily focussed on liveability through the environmental considerations in its vision (CoC, 2018a,b,c). This is clearly concluded from the S1 analysis.

Specifically, it adopted many (59) initiatives and delivered the most benefits (235 impacts overall) of the four cities, 199 being direct and 36 indirect impacts with a star rating of 572. There are 20 active initiatives. All four Lenses have been affected in a significant way; it is also encouraging, for future visioning and association with other (green) agendas, which a large proportions of the impacted Actions, belong to the Environment Lens (106). The Society Lens (74 impacted Actions) and Environment Lens together account for most of the impacts, as there are markedly fewer for Economy & Finance (40) and fewer still for Governance & Policy (15) Actions.

Singapore's particularity as being smart (nation, in this case) is an interesting feature of the analysis. The national government set the smart agenda and initiatives were supported by government organisations, primarily to enhance citizen services using digital systems (SNS, 2018; GovTech, 2018). Although it has a large number of adopted active initiatives (52) it achieved the lowest score of 125 impacts (64 direct and 61 indirect) with an overall star rating of 255, delivering the lowest breadth of benefits to its population. Singapore has 20 active initiatives. The assessment showed the maximum benefits were delivered in the Society Lens (69 impacts), with an approximately even spread of impacts across the other Lenses: Economy & Finance (12), Environment (17), and Governance & Policy (17). There were significant impacts in terms of supporting the 'maximising cultural benefits (health, recreation, opportunities for outdoor learning)' Action in the Environment Lens; however, this Lens had very few of its Actions supported overall.

The SMART S1 assessment yielded interesting results. Considering both the number of initiatives (whether active or completed) and the delivered benefits (i.e. impacts) on the wider population shows that the move towards (true) smartness does not depend solely on the number of initiatives adopted. For example, although London has a greater number of initiatives (and a greater number of active ones), it showed less overall benefits from Birmingham. Looking at the two UK examples and their similarities, one could argue that these two cities are equally smart or equally unsmart. However, to counter this statement, the case study of Singapore shows the largest number of initiatives but has delivered the fewest benefits (with markedly less impacts than Birmingham and London). All these are shown in Appendix E – a comparison of the four case studies. Additionally, all three showed that the Environment Lens suffers from a low number of affected Actions, in contrast to Copenhagen,

which has implemented a liveable/green agenda in its actions. Therefore, it can be concluded that the two UK examples demonstrate a better smart agenda (better affecting liveability) compared with Singapore, but are less successful compared to Copenhagen because of its stronger focus on environmental matters, which have been shown to manifestly improve people's wellbeing (Wiking, 2011; EGCS, 2014; CoC, 2018a,b,c). From this, cities can explore the design of initiatives, and their implementation, to replicate the smart agenda of Copenhagen shaped by their own specific contexts.

Interestingly, the expectations of Smart Nation Singapore fell short, as the analysis shows that digitalisation focussed on the Society Lens does not necessarily support truly smart, liveable cities. Thus, while the implementation of the smart agenda in Singapore is a faster process due to links with governmental collaboration; however, in the future, liveability could (and should) be considered in decision-making processes, starting by emphasising liveability in the overall smart vision, and the rapid implementation in Singapore could bring about a rapid change towards enhanced liveability.

Given that, in accordance with the primary thrust of this thesis, it is desirable that a truly smart agenda supports the greatest number of liveability Actions and the widest impact on the population; implementing fewer but better-designed smart initiatives is the recommended way forwards. This is achievable by making sure that proposed initiatives can impact as many of the (Lenses) Actions as possible. In the next section, the discussion is enriched by the experts' opinions on smart cities.

7.2.3.1 Strand Two S2 - Birmingham, London

Discussions with experts in Birmingham and London revealed interesting views that could affect initiatives' priorities. Experts from both cities expressed views that support the findings of the S1 analysis regarding the need for a stronger focus on the Environmental Lens. For example, Birmingham should adopt initiatives that support Actions in the Environment Lens to achieve lower carbon emissions to enhance liveability, and should do this through initiatives that have a holistic green agenda (Participant 1; Participant 3; Participant 4; Participant 5). Although S1 showed a concentration of initiatives affecting the Societal Lens, especially in the cases of those implementing digital solutions, they should be refined so that they deliver benefits for deprived areas and ensure a fair agenda for all (Participant 1; Participant 4; Participant 5). This is crucial to address adverse perceptions of digital disparity in smartness. This argument extends to the Economy Lens of the

initiatives, because, usually, private organisations are involved in smart cities and this has caused further inequality by disadvantaging those who are economically worse off. Therefore, emerging business models should involve all stakeholders, such as those that seek to enhance participation using open data systems operated by BCC (Participant 1; Participant 3; Participant 5). However, further balanced support of liveability Actions needs to be delivered by BCC's initiatives, as the 'democratic character' of the initiatives must be seen to be at the heart of smartness and central to achieving a more liveable vision delivered by the local governance (City Council) (Participant 3; Participant 4; Participant 5).

In the London case study, the smart city's benefits were highlighted as being directed not only towards those participating as users, but were intended to be delivered to people more generally (Participant 9; Participant 6). Similar to Birmingham, deprivation is a priority among the challenges that the city faces, and a digital agenda needs to ensure inclusivity even for those that are not part of the 'digitalisation skilled' (Participant 6; Participant 8; Participant 9). There was recognition of the need for a strong environmental response in Smart London, especially in respect of mobility, where private organisations can play a big role, for example TfL and Arup, but it should be ensured that these are not structured for individual benefit but for the general good (Participant 7; Participant 8; Participant 9). It seems that the truly smart agenda of London is highly dependent on the support of the capital's economy, given the fact that London engages in international collaborations and, therefore, a collaborative agenda between companies and citizens is required (Participant 7; Participant 9). Due to this, London needs to focus on its governance agenda, to provide leadership and enhance stakeholder collaborative solutions both for the London boroughs (for example, in terms of mobility connections) and London's international connections (Participant 6; Participant 7; Participant 9).

Both of cities that were explored in the S2 analysis showed that, although there is a general idea of how true smartness should be implemented, each city should have a different agenda, i.e. one that has additional features. For example, Birmingham should focus on delivering impacts that support those Environmental and Societal Actions that are either not supported or have minimal support to deliver a more balanced liveable approach to smartness. Likewise, in London, stronger support for Societal

Actions towards liveability is important, especially in terms of impacts on enabling mobility for all. Both cities should also focus on Environmental Actions, which could also present opportunities for the low-carbon agenda in truly smart cities.

7.2.3.2 Additional Benefits for the Low-Carbon Agenda

Smart cities' visions and changing political agendas can cause complexity and, albeit unwittingly, mismanagement in their implementation. Undoubtedly, the smart agenda is affected by (and able to deliver benefits in support of) the CO_2 agenda. However, the benefits have not been fully realised so far to show how smartness has substantially impacted the green agenda (Cavada *et al.*, 2015). Whilst smart can – and does – provide technological interventions that lead to efficiency benefits, the long-term liveability benefits have not yet been established. It is, therefore, impossible to examine how strongly the green agenda relates to the smart agenda. This is demonstrated in Birmingham, where the Smart Commission has a connection to the Green Commission, yet they are two distinct bodies; such connections should be further developed. An exploration of the smart initiatives that could offer benefits to a low-CO_2 agenda can be achieved using SMART to identify key Goals and Actions, and to prioritise new initiatives to determine further association with green benefits in smart cities. For example, the smart agendas of Copenhagen and Singapore show how these are context-dependent: Copenhagen's vision is to build green technologies in an ecosystem of knowledge and skills; whereas Singapore's shorter technology-led legacy is rooted in its own people-first smart vision. For Singapore, and other cities, it is not possible to adopt the same smart practices in the expectation that they would lead to the '*Copenhagensation* of cities' because it worked in one specific city (Cavada *et al.,* 2015) – it worked in Copenhagen because all of the necessary conditions were in place (Rogers, 2018).

The liveability assessment that is performed in this thesis can assess smartness according to specific urban contexts, reducing the existing complexity of smart and the uncertainty as to whether an initiative would deliver its intended benefits. A possible further addition to SMART (similar to the additional S2 local experts' opinions) would be an explicit process to take into consideration the 17 Sustainable Development Goals SDG's (UN, 2015) when designing, or assessing, smart initiatives. As such, it is suggested that liveability Goals should be mapped onto sustainable Goals so as to

provide an additional approach when assembling city data prior to developing smart city initiatives (Cavada *et al.*, 2017). Indeed, bespoke, city-context dependent additions to the liveability assessment for smart cities conducted in this thesis should be part of the city vision, which should be free from a political 'colour' agenda and should deliver long-term benefits to the wider population.

7.1.4 Limitations

There are three main limitations to this research:

i. In particular, the complexity of smartness defines the biggest limitation was the complexity involved in defining smartness (Cavada *et al.*, 2015). This thesis has adopted a logical and defensible position on the assessment of the (contemporary) liveability aspects of smartness, yet other interpretations may emerge and be championed as perceptions of liveability change. Smartness, and all its dimensions, should be considered a dynamic topic.

ii. City agendas adopt smart initiatives according to context and time, and are funding-specific, often following an agenda shaped by appropriate city aspirations (Rogers, 2018), which are also open to interpretation.

iii. Delays in initiatives' implementation can happen due to a lack of resources (people, money, and capability in the form of a 'smart city department' and/or skills), changing political agendas, and the influence of experts' opinions; delays in implementation can also mean a change of context in which the initiatives are to deliver their impacts, thereby potentially compromising their effectiveness. Any analysis is conducted at a point in time, and on the basis that initiatives are implemented as intended; such an analysis should be adjusted, or redone, if the circumstances change.

For these reasons, the research focused on the impacts of liveability as defined by the Liveable Cities programme. The two-strand approach of SMART provides evidence of the initiatives' likely efficacy using a liveability assessment of the documents describing smart city initiatives (S1), and following discussions with local experts (S2). This, points to a lack of support for liveability Actions and the need to prioritise newly proposed initiatives, or changes to existing ones, and ensure that decisions are made in a timely manner (Anthopoulos and Reddick, 2016).

7.3 Recommendations for Truly Smart Cities

A list of recommendations is provided here to show how cities can create a truly smart agenda (and design initiatives) to deliver enhanced liveability while also supporting the city's vision. Both UK case study cities have shown a similar approach to incorporating liveability in their smart agendas and have a high number of completed initiatives; in the case of London, this being attributed to governance changes. This implies that more impact on liveability Actions could be achieved if these were still active. Furthermore, the two UK cities suffer great imbalances in terms of the Actions impacted by their initiatives. Although this is an indication of the contextual circumstances that characterise each city, the SMART analysis shows explicitly how these are distributed and, furthermore, where new initiatives can be prioritised (reinforced by observations from application of the S2 Strand) to support a better balance of Actions impacted by smart initiatives. For the Birmingham case, the following are suggested:

i. Initiatives should enhance the green agenda in smartness.

ii. Consider initiatives that address social issues that are not currently supported should be considered.

iii. Transport initiatives that support low-energy transportation, while supporting social cohesion and safety, should be devised.

iv. Initiatives that support how resources are governed (energy, water, waste, food) via a holistic approach should be considered, i.e. initiatives that have an impact across actions and provide benefits for all these areas at the same time. This is because resource issues are highly interdependent.

v. Greater consideration should be given to individuals, via closer engagement with the public, potentially through the existing collaboration centres (iCentrum and Innovation Birmingham).

London should also prioritise Environmental Goals in proposed initiatives, with the primary recommendations being:

i. The main priority for a truly smart London is adopting initiatives that affect Actions of the Environment goal.

ii. In support of the Environment Goal's Actions, London should adopt and support initiatives related to mobility, promoting alternative environmental modes of transport, with the aim of improving safety and wellbeing.

iii. Initiatives in support of resources should, as was recommended for Birmingham, be considered in holistic terms and should simultaneously consider energy, water, and waste.

iv. The digital capabilities of the capital should enhance the Societal agenda and be designed to bridge the digital divide, adopting solutions for the low digitally-skilled section of the population.

v. Economic equalities need attention; initiatives that promote an ecosystem of collaboration and fair governance in large city agencies are recommended to avoid too strong a focus on the commercial benefits.

vi. London's changes to its smart plan should be a continuation of its vision, rather than an implementation of new smart vision agendas that focus on short-term political agendas.

7.4 Contribution to Research

So far, the smart cities research has shown complexity in its attempts to extrapolate the meaning of smartness, even when it is used as one of many other thematic city approaches. This in turn creates complexities not only in terms of assessment but also in the characterisation of smart city rating systems. Smart, for many, is related to digital technology; this research goes beyond this single concept to explore the development of cities that are truly smart — cities that deliver individual and societal wellbeing.

For this reason, this research has explored the delivery of true smartness in the form of liveability. Existing smart city assessment tools do not have the ability to examine whether smart cities are truly smart (liveable) and, while tools assessing sustainability (e.g. SPeAR®) might show similarities, they do not fulfil the hypothesis of this research. CityLIFE is the only tool that is able to comprehensively assess liveability, and for this reason, this research incorporated it while developing SMART. SMART (the two-strand assessment of S1 & S2) contributes to the wider smart city research in two ways: it explores the implementation of the smart agenda through an analysis of the city's documents (found in the smart city agenda of the city), an open and transparent that can be followed by different professionals and always yield a similar outcome; and it develops the discourse of smartness with

experts, which can be used to define the priorities for additional benefits. Results from the SMART analysis can be related to the overall city vision and changes to political agendas should be overcome.

Further, in helping to shape future visioning, SMART can be used to provide additions to the current smart agenda and initiatives in a city. Suggestions also require a bottom-up and socially-focused perspective of smartness, which could be provided in the S2 analysis. Additions are also recommended to include the UN's Sustainable Goals and low-carbon policies, and these agendas could also be drawn on to adjust tools that analyse the sustainability of projects, such as SPeAR® (UN, 2015; Arup, 2013).

CHAPTER 8: CONCLUSION & FURTHER RESEARCH RECOMMENDATIONS

8.1 Introduction

The aim of this research thesis was to explore methods to aid the enhancement of the liveability of smart cities. Overall, smart cities showed uncertainty in their conceptualisation, often driven by profit or conflicting political agendas. As discussed early on, the term 'smart' was described by the author, in one of her early papers, as being contested, meaning that a clear distinction between these general and wide-ranging definitions of 'smart' and smartness that puts people at the centre of the definition and delivers liveability was required. This has been explored in the critical review of the literature, and the term 'truly smart' has been used in this thesis to provide the distinction. This term, and concept, has been used when researching the realisation of smartness in the smart city cases analysed in this thesis, and similarly it has been used in the evaluation of the smart assessment tools. Accordingly the hypothesis being tested in this thesis includes the term 'truly smart', meaning that smartness should deliver liveability benefits as researched in depth in the *Liveable Cities* project.

The main objective in this research has been the development of an assessment tool that can provide clarity and help guide the implementation of liveability as part of realising the true meaning of smart, i.e. in accordance with the definition of 'true smartness' adopted throughout this thesis. Therefore, a new tool – the Smart Model Assessment Resilient Tool (SMART) – has been developed to explore the current smart city agendas (reflected in a city's policies and initiatives) being adopted by cities in terms of their true smartness and to support recommendations for the better development of truly smart cities. In the following sections, this chapter lists the findings from this research.

8.2 Unique and Important Findings

i. The term 'smart' so far has been used as an umbrella term for (usually more efficient) service provision; it is suggested here that the term 'truly smart', and its underpinning concept that refers to the those policies and initiatives that deliver individual, societal, and planetary well-being outcomes, should be used to assess the efficacy of these policies and initiatives.

ii. Due to current ambiguity, 'smart' aims shift according to dynamic (e.g. political) leadership agendas and are affected by current fiscal priorities; the balance of focus needs to be restored to provide an agenda that will set the parameters beyond changing political agendas and will foster individual and societal wellbeing, and planetary wellbeing, in a movement towards truly smart cities.

iii. SMART provides clarity in the context of smart cities to identify the smart benefits (direct and indirect impacts) that are likely to derive from each of the city's initiatives, exploring the timeframes and effect on the population of those impacts, and identifying the essential degree of support for the Actions to move the city towards the true aim of smart cities, which is to deliver liveability alongside other agendas (such as sustainability and resilience).

iv. SMART assessment shows that the size, whether it is the capital city (or not) or a smart nation, does not determine the level of liveability. The S1 analysis, which critically reviews the documentation on a city's smart initiatives, shows that Birmingham's smart approach has more indirect impacts than direct impacts on Actions in support of liveability, whereas London has an equal number of direct and indirect impacts on liveability Actions. Copenhagen has a good representation of impacts across the four liveability Lenses, while Singapore shows the lowest number of liveability benefits (i.e. it recorded the smallest number of impacts from its initiatives). Implementation of the S2 analysis for Singapore, in particular, would be advantageous in developing smart initiatives for that would deliver greater liveability benefits.

v. Both Birmingham and London (and, even more evidently, Singapore) lack initiatives that support liveability Actions in the Environmental Lens. Copenhagen, in contrast, has the strongest focus on the planetary wellbeing aspects of liveability, with the highest number of impacts in support of Actions in the Environmental Lens.

vi. Further clarity from discussions with local experts (the S2 analysis of SMART) suggested that Birmingham should consider its deprived areas in the development of new initiatives and incorporate environmental initiatives. In London, while environmental issues also require consideration, a focus on societal issues is important, as well as mobility.

vii. Low carbon emission, as well as the societal considerations noted above, were emphasised in the S2 discussion with local experts in both Birmingham (6.2.1.3) and London (6.3.1.3). Mobility

considerations might be framed as collaborations, which were suggested more generally as suitable for the enhancement of the London smart agenda, since they would align with the city's overall vision for openness.

viii. The impacts of initiatives on actions are not distributed equally for the four cities, nor do they cover all Lenses equally; a more uniform balance of benefits from the cities' initiatives is needed to contribute to the liveability of smart cities according to each city vision. The best example in terms of true smartness of the four is Copenhagen.

It has been demonstrated that further clarity has been achieved by using the SMART analysis of four case studies and the results are able to support further prioritisation of current and proposed initiatives, thereby affecting decision-making in cities. Furthermore, the recommendations made in the following section (8.3) have the potential to further enhance smart city research.

8.3 Further Research - Recommendations

This research has yielded further recommendations that can achieve truly smart cities. To build on the conclusions of this research, the following further research is recommended:

i. Smart cities to implement a vision for lower carbon practices, which would deliver additional benefits to the city, as well as supporting policy for the intergovernmental achievements of national carbon targets (as stressed in the IPCC, D1, 2018, p25).

ii. Smart city research should include fiscal considerations (for example, establishing a local authority's economic impact) using Cost Benefit Analysis (CBA) and/or Cost Effective Analysis (CEA) in order to explore the priorities of initiatives according to government and local funding, as additions to the SMART, as noted in Sections 4.2, 4.4, and 4.6 .

iii. Research should use the SMART (S1 and S2) assessment for a wider spectrum of cities to create further smart city comparisons – i.e. EU capitals and other geographical contexts, and cities internationally.

iv. Another addition to SMART is the implementation of the 17 Sustainable Development Goals, as these are set by the United Nations agenda (UN, 2017) and are recognised internationally as being of importance. Equally, consideration of the 2030 agenda for the implementation of smart would be

helpful, as would consideration of gender equality issues, to ensure public participation without discriminatory actions (UN, 2015).

As a final observation, it is believed that this research has added clarity and specific knowledge to the wider spectrum of what smart is; not only that, but it has also added to existing knowledge in terms of defining truly smart cities as cities that embrace liveability. This sets a basis for implementing smart cities not through a single lens, but with an overall agenda that delivers both individual and societal wellbeing alongside planetary wellbeing. As has been demonstrated through each case study, each smart city has different challenges and opportunities that the smart agenda can help to address. A comparison of the case studies concluded that three of the case studies (Birmingham, London, and Singapore) lack initiatives that focus on environmental considerations, whereas the fourth (Copenhagen) reflects the need for the environment to be at the heart of its smartness; however, none is perfect, and the move to smartness should be considered a journey that is influenced by the dynamic contextual changes that cities inevitably experience.

This research has set the liveability paradigm as an addition to the current literature for smartness, hoping that further leverage will be based on what this research considers to be truly smart. From the findings of this research, smart cities can develop their own agenda for the future, based on their context, vision, and liveability assessment, with a clearer understanding of how to perceive, assess, and implement smartness.

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APPENDICES

APPENDIX A STRAND ONE S1 BIRMINGHAM

A. 1 Initiatives & Initiations

BIRMINGHAM INITIATIVES & INITIATORS					
ID	**Birmingham Initiative**	**Description**	**Source**	**Initiators**	**Reach**
1.	Smart City Roadmap	*strategic framework for leadership and support cooperation with citywide partners to develop a sustainable and better future for our citizens*	http://s3-eu-west-1.amazonaws.com/digitalbirmingham/resources/Birmingham_Smart_City_Roadmap_revised-Nov-2014.pdf	City Council	**C**
2.	Big Data Corridor	*Using data analysis and visualisation for to develop new products and services*	http://digitalbirmingham.co.uk/project/big-data-corridor/	City Council	**A**
3.	Birmingham Data Factory	*Online platform for West Midlands Combined Authority organisation sharing data*	https://data.birmingham.gov.uk/	City Council	**A**
4.	H2020 City4Age - City services for healthy ageing	*urban communities to facilitate the role of social/health services and of families dealing with frailty in the elderly population*	http://digitalbirmingham.co.uk/project/h2020-city4age-city-services-for-healthy-ageing/	City Council	**A**
5.	Smart Routing	*people combining real time journey data information*	http://digitalbirmingham.co.uk/project/smartrouting/	City Council	**C**
6.	Eastern Growth Corridor	*A smart city demonstrator along the Eastern Corridor provides to lever and integrate city centre investment*	http://digitalbirmingham.co.uk/project/east-birmingham-smart-city-demontrator/	City Council	**A**
7.	Pure Cosmos **PU**blic authorities **R**ole **E**nhancing **CO**mpetitiveness of **SMes**	*supporting SMEs and promoting modernisation of public services*	http://digitalbirmingham.co.uk/project/pure-cosmos/	City Council	**A**
8.	H2020: PULSE (Participatory Urban	*data sources and big data analytics to transform public health from a reactive to a predictive system,*	http://digitalbirmingham.co.uk/project/h2020-pulse-participatory-urban-	City Council	**A**

	Living for Sustainable Environments)	*and from a system focused on surveillance to an inclusive and collaborative system supporting health equity*	living-for-sustainable-environments/		
9.	Digital and Financial Literacy Birmingham	*tutor-led workshops to build digital and online skills to benefit the community on health and wellbeing*	http://digitalbirmingham.co.uk/project/digital-and-financial-literacy-birmingham/	City Council	**A**
10.	HS2 Digital Futures Prospectus	*vision and strategy to inform HS2 investment for future technologies and digital systems in a sustainable approach to support local regeneration and deliver an economic, social and environmental legacy*	http://digitalbirmingham.co.uk/project/hs2-digital-futures-prospectus/	City Council	**A**
11.	Project DISC (Data-driven Interactive Smart Decision Toolkit)	*a toolkit to support the ecosystem for management and interpretation of data in cooperation with existing initiatives*	http://digitalbirmingham.co.uk/project/project-disc/	City Council	**C**
12.	Coding Bham	*events for kids (under 18) to adhere coding skills*	http://digitalbirmingham.co.uk/project/coding-brum/	City Council	**A**
13.	Share-PSI 2.0	*a network aiming in the re-use of public sector information of technical standards and support data strategies, policies, and action plans*	http://digitalbirmingham.co.uk/project/share-psi-2-0/	City Council	**C**
14.	Connection Voucher	*Funding for local businesses to support broadband connectivity*	http://digitalbirmingham.co.uk/project/birmingham-connectivity-voucher-scheme/	City Council	**C**
15.	DISCOVER – Skills for Carers	*Support digital skills of health carers and engage them in a flexible manner*	http://digitalbirmingham.co.uk/project/discover---skills-for-carers/	City Council	**C**
16.	The Greater Birmingham Digital Academy	*digital business support skills for more than 400 small/medium businesses*	http://digitalbirmingham.co.uk/project/the-greater-birmingham-digital-academy/	City Council	**A**
17.	Birmingham Data & Skills Hub	*Funding for data to accelerate open data extraction from the council to the open data hub*	http://digitalbirmingham.co.uk/project/breakthrough-fund-release-of-data/	City Council	**C**

18.	Service Directory & Referral System (My Work Journey)	*convert paper based system on to an online system for Universal Support scheme*	http://digitalbirmingham.co.uk/project/service-directory-and-referral-system-sdrs/	City Council	**C**
19.	Small Business Digital Capability Challenge Fund	*innovative support system for SMEs in the digital revolution and align them with national programmes*	http://digitalbirmingham.co.uk/project/small-business-digital-capability-challenge-fund/	City Council	**C**
20.	Wireless in Public Buildings	*fund awarded for free broadband internet on more than 200 public buildings, to enhance citizens connectivity*	http://digitalbirmingham.co.uk/project/wireless-in-public-buildings/	City Council	**A**
21.	Birmingham Free Wi Fi	*free wifi for people with no usage limits*	http://digitalbirmingham.co.uk/project/birmingham-free-wifi/	City Council	**A**
22.	Complex Challenges Innovative Cities	*grow and enhance web-based, innovative solutions for smarter urban life of citizens*	http://digitalbirmingham.co.uk/project/ccic/	City Council	**C**
23.	Start-ups Optimising Urban Life with Future Internet	*enhancing innovation in the public sector, collaboration between local and regional authorities, public entities and other stakeholders*	http://digitalbirmingham.co.uk/project/soul-fi-start-ups-optimising-urban-life-with-future-internet/	City Council	**C**
24.	SmartSpaces	*enabling public authorities in Europe to significantly improve their management of energy in the buildings they occupy*	http://digitalbirmingham.co.uk/project/smartspaces/	City Council	**A**
25.	Aston Computers in the Home	*more than 700 computers offered for families in Aston*	http://digitalbirmingham.co.uk/project/computers-in-the-home/	City Council	**C**
26.	Birmingham Civic Dashboard	*combining public data and civil engagement, services for citizens, reporting issues and complaints*	http://digitalbirmingham.co.uk/project/birmingham-civic-dashboard/	City Council	**C**
27.	Keeping IT in the Family	*cartoon to support older family members*	http://digitalbirmingham.co.uk/project/keeping-it-in-the-family/	City Council	**C**

28.	Universal Credit Pilot	*a sustainable tenancy programme, ensuring digital and financial inclusion*	http://digitalbirmingham.co.uk/project/universal-credit-pilot/	City Council	**C**
29.	Smart City Commission	*a programme to support and deliver the Smart City Commission development of Smart City Roadmap*	http://digitalbirmingham.co.uk/city/about/smart-city-commission/	City Council	**U**
30.	Birmingham Smart City Alliance (SCA)	*connect partners to develop smart city projects and solutions*	http://s3-eu-west-1.amazonaws.com/digitalbirmingham/resources/Birmingham_Smart_City_Roadmap_revised-Nov-2014.pdf p12	City Council Digital Birmingham	**C**
31.	Birmingham Science City (BSC)	*establishing three working groups for low carbon, health and digital –developing and progressing projects, many of which link directly with the smart city agenda*	http://s3-eu-west-1.amazonaws.com/digitalbirmingham/resources/Birmingham_Smart_City_Roadmap_revised-Nov-2014.pdf p12	City Council Digital Birmingham Sustainability West Midlands	**C**
32.	Innovation Birmingham Ltd	*technology campus offers space, services and entrepreneurial support to technology companies playing a vital part in supporting the skills for a smart economy*	http://s3-eu-west-1.amazonaws.com/digitalbirmingham/resources/Birmingham_Smart_City_Roadmap_revised-Nov-2014.pdf p12	City Council Digital Birmingham	**C**
33.	West Midlands Open Data Forum	*develop open data applications and standards, engage with data owners and challenge and progress the publication of data*	http://s3-eu-west-1.amazonaws.com/digitalbirmingham/resources/Birmingham_Smart_City_Roadmap_revised-Nov-2014.pdf p12	City Council Digital Birmingham	**A**
34.	Birmingham Connected	*developing a new direction for transport, reinforcing its role for a successful, vibrant, healthy and sustainable city*	http://s3-eu-west-1.amazonaws.com/digitalbirmingham/resources/Birmingham_Connected_Final_Low_Res.pdf	City Council Eastern Corridor Smart Demonstrator	**A**
35.	Birmingham Development Plan 2031	*development strategy plan for growing population, housing, economy, connectivity, employment*	http://s3-eu-west-1.amazonaws.com/digitalbirmingham/resources/Birmingham-Development-Plan.pdf	City Council Eastern Corridor Smart Demonstrator	**A**
36.	East Birmingham Prospectus	*maximising benefits of opportunities, supporting economic growth through employment and skills, connectivity, and delivering growth*	http://s3-eu-west-1.amazonaws.com/digitalbirmingham/resources/East-Prospectus-February-	City Council Eastern Corridor Smart	**A**

			2015-FINAL.pdf	Demonstrator	
37.	Code Club	*a club of volunteers and educators, offering free coding for young people between 9-13*	https://www.codeclub.org.uk/	Coding Brum Digital Bham	**A**
38.	Serendip Smart City Incubator	*Smart City Incubator provides market access and expertise for digital start-ups through close partnerships with major organisations, accelerating the early growth of new business*	https://www.innovationbham.com/serendip-smart-city-incubator	Innovation Birmingham City Council	**A**
39.	Climate KIC	*accelerating climate innovation clusters around local strengths of the new climate economy*	http://www.climate-kic.org/countries/uk-ireland/	Innovation Birmingham City Council	**A**

A.2 Benefits & Impacts

BIRMINGHAM BENEFITS & IMPACTS			
ID	**Birmingham Initiative**	**Aims and Intended Benefits**	**Impacts (Direct and Indirect Benefit)**
1.	Smart City Roadmap	*The Smart City Roadmap aims to lay out the principles the City needs to follow; describe activities to undertake; respond to challenges*	**Direct** –Addressing low economic performance, unemployment and skills gap; tackling health and wellbeing inequalities; the need for seamless and effective mobility; establishing a low carbon society **Indirect** –connectivity, planning for digital infrastructure, information market place; health, wellbeing and care; ICT and energy efficiency, mobility; digital inclusion, skills and employment, innovation
2.	Big Data Corridor	*Aims to combine datasets*	**Direct** – create data environment **Indirect** – health, wellbeing, mobility
3.	Birmingham Data Factory	*Aims to Open Data from West Midlands Combined Authority*	**Direct** – open datasets **Indirect**–economy (economic agenda)

4.	H2020 City4Age - City services for healthy ageing	*Aims to activate urban communities to facilitate the role of social/health services and of families dealing with Mild Cognitive Impairment (MCI) and frailty in the elderly population*	**Direct**– capture data using sensing technologies **Indirect** – improve living for the elderly and behaviour change
5.	Smart Routing	*Aims to support integrated multimodal journey planning combining real-time and personal data*	**Direct** – personalise transport information **Indirect**– innovation, social value
6.	Eastern Growth Corridor	*Aims to tackle local problems in a more holistic, layered and integrated way*	**Direct** – connect urban clusters *(mobility & connectivity, health, skills & enterprise, information marketplaces)* **Indirect** – new models for service delivery through civic and social enterprise
7.	Pure Cosmos **PU**blic authorities **R**ole **E**nhancing **CO**mpetitiveness of **SMe**s	*Aims to increase and develop SMEs with the improvement of effectiveness of public sector support and with the decreasing of administrative burdens through selected policy instruments* *Aims to exchange good practices on the role that public authorities can play with partners across Europe and enhance the competitiveness of SMEs by improving the business climate and support in which they operate*	**Direct**– improve the public sectors by supporting SMEs **Indirect** – inform strategy on government level, increase ESIF fund and competiveness of SMEs
8.	H2020: PULSE (Participatory Urban Living for Sustainable Environments)	*Aims to leverage diverse data sources and big data analytics to transform public health*	**Direct**–evidence-driven and timely management of public health events and processes **Indirect**– health, community resilience and well-being in cities
9.	Digital and Financial Literacy Birmingham	*Aims to deliver Digital and Financial Literacy in Birmingham*	**Direct**– online access and computer skills **Indirect** –inclusive neighbourhood, better informed in making decisions on health and wellbeing, energy management use, increased employment prospects and ability to make financial savings
10.	HS2 Digital Futures Prospectus	*Aims to set out a vision and strategy to inform and influence how HS2 investment*	**Direct**–use existing and future technologies and digital systems in a sustainable and integrated approach **Indirect** –to support local regeneration and deliver an economic, social and environmental legacy

11.	Project DISC (Data-driven Interactive Smart Decision Toolkit)	*Aims to aim is to develop the data economy for Birmingham and the region*	**Direct**– data economy of Birmingham; exploits the value of open, closed, commercial and personal data for better decision making **Indirect** Benefits –inform policy and strategic service developments using unified data
12.	Coding Bham	*Aims to support a network of coders and designers that will use their digital skills and creativity to address social and economic challenges*	**Direct**– event coding skills, build products using open data **Indirect**—attract young coders, and those that want to learn, from underprivileged and minority backgrounds
13.	Share-PSI 2.0	*Aims to re-use of public sector information and help stakeholders to reach consensus on technical standards complementing existing and ongoing initiatives in the domain*	**Direct** –consensus on technical standards **Indirect**–organisations that effectively interface between government and citizens
14.	Connection Voucher	*Aims to fund SMEs for superfast broadband*	**Direct**– broadband connectivity **Indirect** Benefits –business growth and development
15.	DISCOVER – Skills for Carers	*Aims to increase digital skills of carers and those they care for to support them in their caring role*	**Direct**– bring together skills and care **Indirect**–innovation, flexible strategy, and engage people, learning opportunities through a community of practice and learner centric social networking tool
16.	The Greater Birmingham Digital Academy	*Aims to provide digital business support skills to over 400 small and medium businesses across the GBSLEP areas*	**Direct –** free training **Indirect –** business improvement and benefits from digital economy
17.	Birmingham Data & Skills Hub	*Aim to accelerate and automate open data extraction and publication processes from Birmingham City Council's proprietary systems onto Birmingham's new Open Data Hub*	**Direct–** Open data extraction and publication **Indirect–**a catalyst to encourage citizens, communities, third sector to understand the value of open data to help solve community issues
18.	Service Directory & Referral System (My Work Journey)	*Aims to Deliver and develop a personalised portal for up to 5000 unemployed citizens; Create a work journey assessment process; Enable 100 staff to complete the Digital Unite Quick Starter Programme to assist citizens*	**Direct–**convert the paper based system being used in the pilot to an online system **Indirect –** identifying ways to change both partner and client behaviours, attitudes, and to reduce future demand on non-traditional gateways for citizens to access support upon entering and remaining in the workplace
19.	Small Business Digital Capability Challenge Fund	*Aims to provide an enhanced, end-to-end, package of innovative business support, targeted specifically at SMEs in order to support them in making the most of the digital revolution*	**Direct –**providing opportunities for new, in-depth, learning **Indirect –**support business to get online and trade online

20.	Wireless in Public Buildings	*Aim to install free public access Wi-Fi has been successfully installed in over 200 buildings across Birmingham*	**Direct** – citizens access to internet **Indirect** –users are able to use job sites, check their email, access training information or simply surf the web
21.	Birmingham Free Wi Fi	*Aims to provide public wifi across the city centre*	**Direct** –residents, shoppers and tourists access to unlimited data services on the go **Indirect** –connectivity (no indirect)
22.	Complex Challenges Innovative Cities	*Aims to improve regional innovation policies by enhancing innovation in the public sector*	**Direct** – innovation for public sector policies; and increasing collaboration between local and regional authorities, public entities and other stakeholders **Indirect** –learn from each other's strengths and weaknesses, to identify key elements to be addressed in their regional context and innovation policy implementation plans
23.	Start-ups Optimising Urban Life with Future Internet	*Aims to grow and enhance web-based, innovative solutions for smarter urban life of EU citizens*	**Direct** – funding for new products (web apps and services) into the market **Indirect** – innovative ideas with clear and social value
24.	SmartSpaces	*Aims to improve the management of energy in the buildings that public authorities occupy (reduce energy demand and water, develop an innovative ICT based energy support and management services)*	**Direct** – improving energy efficiency **Indirect** –ICT based management
25.	Aston Computers in the Home	*Aims to transform Aston into a computer literate, internet capable and connected community*	**Direct** –700 Aston families to benefit from a computer **Indirect** –collaboration between the IT industry, local authority, school and local community has extended IT to diverse communities and allowed parents and pupils to share educational content and information
26.	Birmingham Civic Dashboard	*Aims to connect Customer First contact database and show trends on an online map, allowing the council and residents to identify 'hotspot' areas where there are common or recurring issues*	**Direct** –combining public data and civil engagement **Indirect** –enables the Council's Customer First team to look at new ways of involving local people in transforming the delivery of services, and get to the root causes of customer complaints and particular issues
27.	Keeping IT in the Family	*Aims to support children in helping their parents, grandparents and older family members learn IT skills*	**Direct** –invaluable educational tool that illustrates the benefits of digital technology in an easy-to-understand way **Indirect** –IT skills / education
28.	Universal Credit Pilot	*Aims to track a customer's housing journey from start to finish making improvements along the way*	**Direct** – access to personalised Digital Log Book, an online portal that helps tenants to manage every aspect of their

			tenancies online **Indirect** –manage and access benefits online; manage financies with simple budgeting tools; gain digital skills; access employment opportunities; view their council tax and rent statements; report repair
29.	Smart City Commission	*Aims to lay the foundation for building Birmingham's Smart City Roadmap*	**Direct** –to shape and inform discussions and we plan to develop a robust stakeholder programme to enable strong citizen and business involvement **Indirect** –create a range of new jobs and be recognised as a global test bed to trial new technologies and services; joined up approach and across sectors (health, social care, housing, waste and energy) provide more personalised services, enable more efficiencies, identify emerging problems and enable more targeted interventions to improve our lifestyle and well-being
30.	Birmingham Smart City Alliance (SCA)	*Aims to bring together partners wanting to develop smart city projects and solutions; drawing its members mainly from the commercial sector*	**Direct** – part of the smart city eco system **Indirect** – benefit commercial sector
31.	Birmingham Science City (BSC)	*Aims to use science and technology to improve prosperity and quality of life in Birmingham and the wider region*	**Direct** –established three working groups for low carbon, health and digital to develop and progress projects **Indirect** –prosperity and quality of life
32.	Innovation Birmingham Ltd	*Aims to support technology companies*	**Direct** –provides space, services and entrepreneurial support **Indirect** –support the skills for a smart economy
33.	West Midlands Open Data Forum	*Aims to progress open data applications and standards, engage with data owners and challenge and progress the publication of data*	**Direct** –data users and people interested in open data **Indirect** –progress the publication of data
34.	Birmingham Connected	*Aims to create a transport system which puts the user first and delivers the connectivity that people and businesses require*	**Direct** –making travel more accessible, more reliable, safer and healthier and using investment in transport as a catalyst to improve the fabric of our city **Indirect** –improve people's daily lives by making travel more accessible, more reliable, safer and healthier
35.	Birmingham Development Plan 2031	*Aims to achieve and the strategy that will underpin future development and regeneration activity across the City*	**Direct** –enterprising, innovative and green city that has delivered sustainable growth meeting the needs of its population and strengthened its position on the international stage **Indirect** –residents will be experiencing a high quality of life,

			living within attractive and well-designed sustainable neighbourhoods
36.	East Birmingham Prospectus	*Aims to work in partnership with Government and local organisations to maximise these opportunities and improve the prospects for the area*	**Direct** –bring both economic and physical improvements for the area and enable the area to maximise the benefits of growth **Indirect** –maximising the benefits presented by the opportunities for the people of East Birmingham
37.	Code Club	Aim*s to a network of volunteers and educators who run free coding clubs for young people aged 9-13*	**Direct** –all children should have the opportunity to learn to code, no matter who they are or where they come from **Indirect** –young people aged 9-13 build and share their ideas
38.	Serendip Smart City Incubator	*Aims to fulfil the commercial needs of any tech and digital business from entrepreneurs and start-ups, to SMEs and scale-ups*	**Direct** –Incubator provides market access and expertise for digital start-ups **Indirect** –partnerships with major organisations, accelerating the early growth of new business
39.	Climate KIC	*Aims to develop climate innovation clusters in these four city-regions – around local strengths of the new climate economy*	**Direct** –accelerate the development of tech and low carbon start-up ventures **Indirect** –facilitate innovative collaboration between business and commercial partners

A.3 Birmingham Overview of Initiatives according to CityLIFE Actions

LENS	GOAL	ACTION	BIRMINGHAM INITIATIVES	1	***	2	**	3	**	4	**	5	***	6	***	7	**	8	***	9	**	10	***	11	***	12	*	13	**	14	*
				Smart City Roadmap		Big Data Corridor		Birmingham Data Factory		H2020 CityLab		Smart Routing		Eastern Growth Corridor		Pure Connect		H2020 PULSE		Digital Financial Literacy Birmingham		HS2 Digital Futures Programme		Project DISC		Coding Bham		Share-PSI 2.0		Connectivity Voucher	
				Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
SOCIETY	Enhance community and individual wellbeing	Promote healthy living and healthy long lives					X				X			X				X												
		Increase the match between city dweller aspirations and wellbeing			X		X				X		X	X				X		X				X			X		X		
		Minimise ill-being									X							X													
		Maximise cultural benefit		X		X					X		X	X					X				X				X				
	Ensure equity (fairness)	Ensure an enabling physical environment to maximise individual capabilities in the context of carbon reduction and resource security												X									X								
		Ensure an enabling social environment to maximise individual capabilities in the context of carbon reduction and resource security		X									X	X									X								
		Ensure an enabling economic environment to maximise individual capabilities in the context of carbon reduction and resource security		X										X									X								
		Ensure an enabling governance environment to maximise individual capabilities in the context of carbon reduction and resource security		X																											
	Enhance biodiversity and ecosystem services	Minimise the impact of urban density on biodiversity												X																	
ENVIRONMENT	Ensure resource efficiency	Maximise cultural services (health benefits, recreation, opportunities for outdoor learning)		X			X						X						X	X						X					
		Increase the match between city dwellers' aspirations and resource efficient living		X																											
		Minimise energy use and waste (including heat and CO2 emissions)			X																		X								
		Increase the match between wellbeing and minimising high-carbon mobilities while maximising low-carbon mobilities and immobilities of people and objects					X																								
		Minimise potable and non-potable water use and waste (including leakage)																													
		Minimise food use and waste																													
		Minimise materials use and waste																													
		Minimise other waste produced and maximise its reuse, recycling, repurposing																													
		Increase awareness of, and interest in, environmental and climate change issues																													
	Ensure resource security	Increase the match between city dwellers' aspirations and resource secure living											X																		
		Maximise sustainable use of low-carbon local energy first and then maximise the security of supply of non-local energy																													
		Maximise sustainable use of local water first and then maximise the security of supply of non-local water																													
		Maximise sustainable use of local food first and then maximise the security of supply of non-local food																													
		Maximise the sustainable use of local materials first and then maximise the security of supply of non-local materials																													
		Maximise sustainable use of local people first (e.g., utilising the local workforce and leveraging local skills) and then maximise the security of supply of non-local people											X																		
ECONOMY & FINANCE	Maximise sustainable financial investment	Maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO2 emissions)		X					X												X									X
	Ensure economic vitality	Uncouple economic vitality from the CO2 emissions associated with economic growth			X																										X
GOVERNANCE & POLICY	Ensure appropriate governance	Uncouple governance structures and timescales from political cycles and 'colour' of governing bodies			X				X		X		X		X		X				X	X		X			X				
	Ensure appropriate policies	Uncouple policy making and policy timescales from political cycles and 'colour' of governing bodies							X		X				X		X					X			X				X		
				Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
				7	4	1	4	0	3	0	6	0	7	7	2	0	2	3	2	2	2	3	4	2	1	1	2	1	2	0	2
		Total impact (Direct/Indirect)			11		5		3		6		7		9		2		5		4		7		3		3		3		2
	multiplier	Star rating(***)			33		10		6		12		21		27		4		15		8		21		9		3		6		2

15	*	16	*	17	* * *	18	*	19	*	20	*	21	*	22	* * *	23	* *	24	* * *	25	*	26	* * *	27	*	28	* * *	29	*	30	* * *	31	* * *	32	* *	33
DISCOVER - Skills for Carers		The Greater Birmingham Digital Academy		Birmingham Data & Skills Hub		Service Directory & Referral System		Small Business Digital Capability Challenge Fund		Wireless in Public Building		Birmingham Free		Complex Challenges Innovative Cities		Start-ups Optimising Urban Life with Future Internet		SmartSpaces		Astro Computers in the Home		Birmingham Civic Dashboard		Keeping IT in the Study		Universal Credit Pilot		Smart City Commission		Birmingham Smart City Alliance (SCA)		Birmingham Science City (BSC)		Innovation Birmingham Ltd		West Midlands Open Data Forum
Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct
																													X							
X					X								X		X		X							X			X		X					X		
	X		X	X							X		X		X		X		X	X			X	X			X			X					X	
																			X																	
	X					X																							X							
						X																														
X		X			X		X		X		X						X		X						X				X						
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			X		X		X				X		X								X			X		X		X								
			X						X							X													X		X			X		
			X						X																				X		X			X		
					X		X						X		X				X					X			X		X							
					X										X																					
Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct
2	3	1	4	1	5	3	4	0	3	0	3	0	4	0	4	1	3	3	4	2	0	0	4	2	2	1	4	1	10	1	2	3	2	1	3	0
	5		5		6		7		3		3		4		4		4		7		2		4		4		5		11		3		5		4	
	5		5		18		7		3		3		4		12		8		21		2		12		4		15		11		9		15		8	

II

*	34	* * *	35	* * *	36	* * *	37	*	38	* *	39	* *										
	Birmingham Connected		Birmingham Development Plan 2031		East Birmingham Prospectus		Code Club		Serendip Smart City Initiative		Climate KIC											
Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	LENS	GOAL	ACTION	DIRECT ACTIONS	INDIRECT ACTIONS		Three ***	Two **	One *	Multiplier
																TOTAL	TOTAL		impacts the whole population	impact to a wider population group	(benefit(s) to only one group	
		X		X															16	9	14	325
X				X				X					SOCIETY	Enhance community and individual wellbeing	Promote healthy living and healthy long lives	2	5	7				
															Increase the match between city dweller aspirations and wellbeing	6	16	22				
				X			X			X					Minimise ill-being	1	1	2				
			X												Maximise cultural benefit	8	17	25				
														Ensure equity (fairness)	Ensure an enabling physical environment to maximise individual capabilities in the context of carbon reduction and resource security	2	2	4				
															Ensure an enabling social environment to maximise individual capabilities in the context of carbon reduction and resource security	3	4	7				
															Ensure an enabling economic environment to maximise individual capabilities in the context of carbon reduction and resource security	2	1	3				
															Ensure an enabling governance environment to maximise individual capabilities in the context of carbon reduction and resource security	2	0	2				
	X													Enhance biodiversity and ecosystem services	Minimise the impact of urban density on biodiversity	2	0	2				
							X						ENVIRONMENT	Ensure resource efficiency	Maximise cultural services (health benefits, recreation, opportunities for outdoor learning)	6	11	17				
			X												Increase the match between city dwellers' aspirations and resource efficient living	2	0	2				
			X								X				Minimise energy use and waste (including heat and CO2 emissions)	5	2	7				
	X		X		X										Increase the match between wellbeing and minimising high-carbon mobilities while maximising low-carbon mobilities and immobilities of people and objects	3	1	4				
			X												Minimise potable and non-potable water use and waste (including leakage)	1	0	1				
			X												Minimise food use and waste	1	0	1				
			X												Minimise materials use and waste	1	0	1				
			X												Minimise other waste produced and maximise its reuse, recycling, repurposing	2	1	3				
			X									X			Increase awareness of, and interest in, environmental and climate change issues	3	3	6				
		X		X								X		Ensure resource security	Increase the match between city dwellers' aspirations and resource secure living	8	0	8				
				X											Maximise sustainable use of low-carbon local energy first and then maximise the security of supply of non-local energy	2	1	3				
				X											Maximise sustainable use of local water first and then maximise the security of supply of non-local water	1	0	1				
				X											Maximise sustainable use of local food first and then maximise the security of supply of non-local food	0	1	1				
				X											Maximise the sustainable use of local materials first and then maximise the security of supply of non-local materials	0	1	1				
						X									Maximise sustainable use of local people first (e.g., utilising the local workforce and leveraging local skills) and then maximise the security of supply of non-local people	0	10	10				
					X					X	X		ECONOMY & FINANCE	Maximise sustainable financial investment	Maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO2 emissions)	5	8	13				
			X									X		Ensure economic vitality	Uncouple economic vitality from the CO2 emissions associated with economic growth	1	9	10				
		X				X							GOVERNANCE & POLICY	Ensure appropriate governance	Uncouple governance structures and timescales from political cycles and 'colour' of governing bodies	5	16	21				
														Ensure appropriate policies	Uncouple policy making and policy timescales from political cycles and 'colour' of governing bodies	1	9	10				
Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect				Direct	Indirect					
1	2	3	10	8	2	2	2	1	0	2	2	3										
1		5		18		4		3		2		5			Total impact (Direct/Indirect)		194					
1		15		54		12		3		4		10		multiplier	Star rating (***)	Star rating (***)	325					

APPENDIX B STRAND ONE S1 LONDON

B. 1 Initiatives & Initiations

LONDON INITIATIVES & INITIATORS					
ID	**London Initiative**	**Description**	**Source**	**Initiators**	**Reach**
1.	A Smarter London together	*A Listening Exercise for a new Smart London Plan*	https://www.london.gov.uk/what-we-do/business-and-economy/supporting-londons-sectors/food-consultation/smarter-london-together	Mayor of London	**A**
2.	Chief Digital Officer	*first appointed Chief Digital Officer to develop city-wide digital transformation as an international centre for innovation*	https://medium.com/@camdentheo/next-steps-in-digital-leadership-and-city-wide-collaboration-in-london-3655876e6cb1	Mayor of London	**A**
3.	Smart London Camp 2018	*first GLA conference, could directly shape digital future, become part of a new Smart London Plan*	https://www.london.gov.uk/what-we-do/business-and-economy/supporting-londons-sectors/smart-london/smart-london-camp-2018	Mayor of London	**C**
4.	Smart London Board	*helping the Mayor shape his vision and strategy for London's smart city agenda and investment in data infrastructure*	https://www.london.gov.uk/what-we-do/business-and-economy/supporting-londons-sectors/food-consultation/food-consultation-board	Mayor of London	**A**
5.	Working with the boroughs / Getting the Show on the Road: Report from the first London Office of Technology	*scoping study in data, digital and technology on the quality and efficiency of public services into tangible outcomes for senior political and managerial leadership in London's frontline public services*	https://data.london.gov.uk/blog/london-office-of-technology-and-innovation-loti/	Mayor of London	**A**

	and Innovation Stand Up				
6.	London DataStore	*free, open, data sharing portal of over 700 datasets for people to understand the city and develop solutions to London's problems*	https://data.london.gov.uk/	Mayor of London	**A**
7.	Sharing cities	*programme supports new smart cities technologies to maximise benefits*	https://www.london.gov.uk/what-we-do/business-and-economy/supporting-londons-sectors/food-consultation/mayor-and-smart/food-consultation	Mayor and Smart	**A**
8.	Infrastructure Map	*interactive tool which lets you explore current and future development and infrastructure projects*	https://www.london.gov.uk/what-we-do/business-and-economy/better-infrastructure/london-infrastructure-map	Mayor and Smart	**A**
9.	About Better Futures	*100 small businesses to boost needs to be successful, and create a hub for low-carbon industries in London*	https://www.london.gov.uk/what-we-do/environment/better-futures/about-better-futures	Mayor and Smart	**A**
10	Digital Connectivity	*improve connectivity, ensuring better access to public-sector property for digital infrastructure, and treating digital infrastructure with the same status as other key public utilities*	https://www.london.gov.uk/what-we-do/business-and-economy/supporting-londons-sectors/connectivity/digital	Mayor and Smart	**A**
11	Smart London	*solving London's environment challenges by bringing together people, technology and data*	https://www.london.gov.uk/what-we-do/environment/smart-london-and-innovation/smart-london	Mayor and Smart	**A**
12	Energy in Buildings	*helping London's homes, businesses and public buildings to use less energy and save money on their energy bills*	https://www.london.gov.uk/what-we-do/environment/energy/energy-buildings	Mayor and Smart	**A**
13	New London plan (opens many pages)	*is the statutory Spatial Development Strategy for Greater London prepared by the Mayor of London ("the Mayor") in accordance with the Greater London Authority Act 1999 (as amended) ("the GLA Act") and associated regulation*	https://www.london.gov.uk/what-we-do/planning/london-plan/new-london-plan/what-new-london-plan & https://www.london.gov.uk/what-we-do/planning/london-plan/new-london-plan/draft-new-london-plan/	Mayor and Smart	**A**

14	Monitoring and predicting air pollution	*improve the way he (the Mayor) informs the public, particularly those who are most vulnerable, about incidents of poor air quality in the capital*	https://www.london.gov.uk/what-we-do/environment/pollution-and-air-quality/monitoring-and-predicting-air-pollution	Mayor and Smart	**A**
15	Draft Economic strategy	*public consultation on the Mayor's draft Economic Development strategy, on opportunities, growth, and innovation*	https://www.london.gov.uk/what-we-do/business-and-economy/have-your-say-economy-works-all-londoners	Mayor and Smart	**A**
16	Draft Transport strategy	*transport strategy with potential to shape London, from the streets Londoners live, work and spend time on, to the Tube, rail and bus services they use every day*	https://www.london.gov.uk/what-we-do/transport/our-vision-transport/mayors-transport-strategy-2018	Mayor and Smart	**A**
17	Digital Talent programme (more initiatives within)	*Digital skills and training*	https://www.london.gov.uk/what-we-do/business-and-economy/skills-and-training/digital-talent-programme	Mayor and Smart	**A**
18	Listening exercise for a new Smart London Plan	*listening exercise / description setting the scene for the development of a new Smart London plan*	https://medium.com/@SmartLondon/a-smarter-london-together-listening-exercise-for-a-new-smart-london-plan-51be7d9ca203	Smart London	**A**
19	The Future of Smart 2016	*update of the 2013 Smart London Plan-harnessing digital innovation*	https://www.london.gov.uk/sites/default/files/gla_smartlondon_report_web_3.pdf	Smart London	**C**
20	London's first Smart park	*Queen Elizabeth Olympic Park is the city's newest, smartest and most sustainable park*	http://www.queenelizabetholympicpark.co.uk/our-story/transforming-east-london/sustainability/smart-sustainable-districts	Mayor of smart	**C**
21	Tech Map London	*a platform provides an unprecedentedly detailed picture of London's vibrant science and technology sector. Through a combination of map visualisations, charts and tabular data*	http://www.techmap.london/	Mayor of London	**A**
22	Smart London Investor Showcase	*a showcase of smart solutions to the Capital's future challenges by the UK business angels association*	https://www.london.gov.uk/sites/default/files/mol_smart_london_showcase_programme_web_for_gla.pdf	Mayor of London	**U**

23	Smart card Oyster	*a smart card which can hold pay as you go credit, Travelcard and Bus & Tram Pass season tickets Use it to travel on bus, Tube, tram, DLR, London Overground, TfL Rail, Emirates Air Line, River Bus services and most National Rail services in London*	https://tfl.gov.uk/fares-and-payments/oyster	Mayor of London	**C**
24	Camden Council – Residents Index (case studies)	*Camden built a "residents' index", uniting information from 16 council data sources to create a single, consistent view of residents across the borough and the council services that they are accessing* ***COMPLETE AND CLOSED DOWN***	http://smarterlondon.co.uk/case-studies/camden-council-residents-index/	Mayor of London Smart London Innovation Network	**C**
25	Sensing London (case studies)	*five "living laboratories" across London, where sensors measure a range of physical parameters, including air quality and human activity* ***COMPLETE AND CLOSED DOWN***	http://smarterlondon.co.uk/case-studies/sensing-london/#more-1001	Mayor of London Smart London Innovation Network	**C**
26	London Living Lab (case studies)	*a city scale environment that is instrumented to enable experiments to be carried out in situ* ***COMPLETE AND CLOSED DOWN***	http://smarterlondon.co.uk/case-studies/london-living-lab/	Mayor of London Smart London Innovation Network	**C**
27	London South Bank University (LSBU) – Exceptional Student Experience (case studies)	*a mix of social, mobile, analytics and security solutions built on cloud infrastructure to provide a dynamic learning experience for students supported by predictive monitoring of their academic progress to help them achieve their potential* ***COMPLETE AND CLOSED DOWN***	http://smarterlondon.co.uk/case-studies/lsbu-exceptional-student-experience/#more-970	Mayor of London Smart London Innovation Network	**C**
28	Making sensors a commodity (case studies)	*optimum combination of sensors to detect footfall and other environmental parameters in bus shelters in bus stops in and around the Shoreditch area, as well as within buildings* ***COMPLETE AND CLOSED DOWN***	http://smarterlondon.co.uk/case-studies/making-sensors-a-commodity/	Mayor of London Smart London Innovation Network	**C**
29	Programme delivery dashboard for Croydon Council	*an extensive regeneration programme that in a period of five-years will involve more than 150 construction projects of all kinds to transform Croydon as a place to live, work and visit*	http://smarterlondon.co.uk/case-studies/programme-delivery-dashboard/	Mayor of London Smart London Innovation Network	**A**

	(case studies)				
30	Rezatech (case studies)	*resolves global business problems caused by environmental change through the scientific analysis of satellite and ground data* ***COMPLETE AND CLOSED DOWN***	http://smarterlondon.co.uk/case-studies/rezatec/	Mayor of London Smart London Innovation Network	**C**
31	Tower Bridge Idling (case studies)	*installing sensors on Tower Bridge road to measure the air quality when the bridge is raised and the potential for behavioural interventions using targeted, real-time public signage* ***COMPLETE AND CLOSED DOWN***	http://smarterlondon.co.uk/case-studies/tower-bridge-idling/	Mayor of London Smart London Innovation Network	**C**
32	Imperial College Data Science Institute (case studies)	*conduct research on the foundations of data science and to foster the development of advanced theory, technology and systems that contribute to the state-of-the-art in data science and big data* ***COMPLETE AND CLOSED DOWN***	http://smarterlondon.co.uk/case-studies/949/	Mayor of London Smart London Innovation Network	**C**
33	Environmental Performance for Small Businesses (case studies)	*developed an online platform that brings sustainability to small businesses on their terms. Integrating with accounting platforms companies already in use, Carbon Analytics makes measuring, reporting and reducing environmental impact simple, engaging and rewarding* ***COMPLETE AND CLOSED DOWN***	http://smarterlondon.co.uk/case-studies/carbon-analytics/	Mayor of London Smart London Innovation Network	**C**
34	Enermap (case studies)	*an online platform that displays the Energy Performance Certificates, along with other energy data in an easy way and with the user in mind.* ***COMPLETE AND CLOSED DOWN***	http://smarterlondon.co.uk/case-studies/enermap/	Mayor of London Smart London Innovation Network	**C**
35	Hyde Park Sensing (case studies)	*a prototype and test an innovative network of wireless sensors, including soil, air, water and more, the project collects unprecedented near real-time data on the park's eco-system and social fabric, and explores how technology can help us manage and experience urban parks in imaginative new ways*	http://smarterlondon.co.uk/case-studies/hyde-park-sensing/	Mayor of London Smart London Innovation Network	**C**

		COMPLETE AND CLOSED DOWN			
36	IBM Bluemix Garage (case studies)	*helping clients adopt the technologies and practices required to rapidly build innovative mobile & web applications on the cloud* ***COMPLETE AND CLOSED DOWN***	http://smarterlondon.co.uk/case-studies/bluemix-garage/	Mayor of London Smart London Innovation Network	**C**
37	IBM and Wimbledon Data and Digital Analytics (case studies)	*a digital platform which gathers, processes and disseminates real-time data on every point of every match* ***COMPLETE AND CLOSED DOWN***	http://smarterlondon.co.uk/case-studies/data-and-digital-analytics/	Mayor of London Smart London Innovation Network	**C**
38	Urban Innovation Centre (case studies)	*a space for urban innovators to work together, so that they can turn ingenious new technologies and processes into real products and services that will be scaled up and used in cities around the world* ***COMPLETE AND CLOSED DOWN***	http://smarterlondon.co.uk/case-studies/urban-innovation-centre/	Mayor of London Smart London Innovation Network	**C**
39	Canary Wharf	*a shared workspace will enable companies to work together to find smart cities solutions, which are capable of operating in an interconnected way, drawing on Big Data and the Internet of Things (IoT)*	http://group.canarywharf.com/media/press-releases/londons-first-smart-city-ecosystem-opens-in-canary-wharf-121115/	Canary Wharf Group plc	**U**
40	Future cities Catapult	*advance urban innovation, to grow UK companies, to make cities better, bring together businesses, universities and city leaders so that they can work with each other to solve the problems that cities face*	http://futurecities.catapult.org.uk/about/	Organisation	**A**
41	Smart city opportunities for London	*smart energy*	https://www.london.gov.uk/sites/default/files/arup-gla_smart_city_opportunities_for_london.pdf p13	Organisation Arup	**A**
42	Smart city opportunities for London	*smart water management*	https://www.london.gov.uk/sites/default/files/arup-gla_smart_city_opportunities_for_london.pdf p20	Organisation Arup	**A**

43	Smart city opportunities for London	*smart waste management*	https://www.london.gov.uk/sites/default/files/arup-gla_smart_city_opportunities_for_london.pdf p26	Organisation Arup	**A**
44	Smart city opportunities for London	*smart transport*	https://www.london.gov.uk/sites/default/files/arup-gla_smart_city_opportunities_for_london.pdf p36	Organisation Arup	**A**
45	Smart city opportunities for London	*health and assisted living*	https://www.london.gov.uk/sites/default/files/arup-gla_smart_city_opportunities_for_london.pdf p42	Organisation Arup	**A**
46	Smart city opportunities for London	*smart city businesses*	https://www.london.gov.uk/sites/default/files/arup-gla_smart_city_opportunities_for_london.pdf p50	Organisation Arup	**A**

B.2 Benefits & Impacts

LONDON **BENEFITS & IMPACTS**			
ID	**London Initiative**	**Aims and Intended Benefits**	**Impacts (Direct and Indirect Benefit)**
1.	A Smarter London together	*Aims to become the smartest city in the world*	**Direct** –secure London's position at the forefront of innovation in smart cities and what is known as advanced urban services **Indirect** –measures for a future, inclusive London in line with mayoral strategies and the London Plan
2.	Chief Digital Officer	*Aims to Provide strategic leadership on the digital transformation agenda for London's public services, across the GLA group and the wider public sector*	**Direct** –build support for and take-up of innovative, technology and data-led approaches to service delivery and public engagement **Indirect**–partnership between the public, private and community sectors to enable and support the development of new public

			service oriented technology and innovation
3.	Smart London Camp 2018	*Aims to shape London's digital future and become part of a new Smart London Plan, to be launched by Mayor Sadiq Khan*	**Direct** –harnessing London's digital talents to improve collaboration and innovation, to investigate how we collectively and collaboratively use data and smart technology **Indirect** –how to make technology work for people
4.	Smart London Board	*Aims to the vision and strategy*	**Direct** –to help the Mayor for London's smart city agenda and investment in data infrastructure **Indirect** –put digital technology and data at the heart of making the capital an even better place to live, work and visit
5.	Working with the boroughs / Getting the Show on the Road: Report from the first London Office of Technology and Innovation Stand Up	*Aims to to turn the talk about the transformative effect of data, digital and technology on the quality and efficiency of public services into tangible outcomes for senior political and managerial leadership in London's frontline public services*	**Direct** –spread digital collaboration; public services in a state of 'technology preparedness; partnerships with the private sector and create relationships with the emerging and innovation-rich govtech sector; meeting our obligations to the General Data Protection Regulation; digital leadership to change culture and ensure progress **Indirect** –digital and data-driven public services in London which truly reflect its standing as a global city, and which will make a difference to people's lives
6.	London DataStore	*Aims to an open data-sharing portal where anyone can access data relating to the capital*	**Direct** –over 700 datasets to help you understand the city and develop solutions to London's problems **Indirect** –visualise or build apps from the data available on the site
7.	Sharing cities	*Aims to support new smart city technologies*	**Direct –**developing a new model of sharing data across cities to make the best use of encyclopaedic amount of information now available that can be used to change the way cities, their communities and services work **Indirect –**deliver a better future for local people
8.	Infrastructure Map	*Aim to explore current and future development and infrastructure projects.*	**Direct** –It gives developers, providers and utilities a clear picture of what developments are taking place **Indirect** –helps them to work together effectively, for example, to plan the phasing of projects reducing disruptions and costs
9.	About Better Futures	*Aims to invest in CleanTech industry - who produce technologies, goods and services that reduce negative impacts on our environment.*	**Direct** –to give 100 small businesses the boost they need to be successful in London **Indirect** –create a hub for low-carbon industries in the city

10	Digital Connectivity	*Aims to Improve connectivity, making it a priority to tackle London's 'not spots', ensuring better access to public-sector property for digital infrastructure, and treating digital infrastructure with the same status as other key public utilities*	**Direct** – improve digital connectivity **Indirect** –best connected city in Europe, where affordable superfast connections are available to homes and small businesses.
11	Smart London	*Aims to solve London's environmental challenges, optimise resources and improve services*	**Direct** –adopt a smarter approach to our work; we estimate that the smart city market will be worth almost £9 billion and around half of this will be from the five sectors of energy, waste, water, transport and health. **Indirect** –extend the life of London's existing environmental infrastructure, reduce costs for Londoners and make savings for London Boroughs and businesses
12	Energy in Buildings	*Aim to help London's homes, businesses and public buildings to use less energy and save money on their energy bills*	**Direct** –Improving existing building stock; Improving the energy performance of new buildings; Overheating and cooling **Indirect** –using new technology on old buildings to make them more energy efficient
13	New London plan (opens many pages)	*Aims to Mayor's general policies in respect of the development and use of land in Greater London and statements dealing with general spatial development aspects*	**Direct** –ensure that the London Plan is consistent with national policies **Indirect** –material consideration in planning decisions; decision maker, but it gains more weight as it moves through the process to adoption
14	Monitoring and predicting air pollution	*Aims to improve the way he informs the public, particularly those who are most vulnerable, about incidents of poor air quality in the capital*	**Direct** –London's air quality is constantly monitored at around 100 different locations; broadcasts air quality advice across London whenever pollution is high or very high **Indirect** –This data will support policy making, and help inform and engage local communities; protect yourself and others by avoiding the car and using back streets to walk and cycle instead
15	Draft Economic strategy	*Public consultation on Opening up opportunities– Growth– ensuring our economy will continue to thrive and is open to business; innovation– to make London a world leader in technology and a hub of new ideas and creativity*	**Direct** –businesses and entrepreneurs to feel supported to grow and innovate, and to enjoy the certainty of knowing that London will remain globally competitive and open to business **Indirect** –a fairer, more inclusive economy; everybody to have a decent standard of living
16	Draft Transport strategy	*Aims to aim to change the transport mix across London, providing viable and attractive alternatives that will allow Londoners to reduce*	**Direct** –bold approach to creating a more liveable city, which will focus London's transport planning on the long-term needs of all Londoners

		their dependence on cars	**Indirect** –vital to making London a fairer, greener, healthier and more prosperous city. A city that is not only home to more people, but a better place to live.
17	Digital Talent programme (more initiatives within)	*Aims to give young Londoners' the digital skills employers want*	**Direct** – fund digital training courses; event talents; funding opportunities; research and resources **Indirect** –inspire young people to join London's booming digital, tech and creative industries; attracting more young women and Londoners from a range of backgrounds to work in the sector
18	Listening exercise for a new Smart London Plan	*Aims to call businesses, public servants, academia, civil society and practitioners for solutions to the city's growth challenges*	**Direct** –fuel for future innovation in business and across London's public services **Indirect** –London can become be the global home to data innovation and artificial intelligence to boost growth and help make London a better place to live, work and visit
19	The Future of Smart 2016	*Aims to put Londoners at the core; access to open data; leveraging London's research, technology, and creative talent; Brought together through networks; To enable London to adapt and grow; City Hall to better serve Londoners' needs; Offering a 'smarter' experience for all;*	**Direct** –Engaging Londoners – using smart technology to enhance the range of ways that we involve and empower Londoners and businesses; enabling good growth – harnessing data and digital technology to meet the growth challenges facing London's infrastructure, environment, and transport systems;. working with businesses – leveraging opportunities for innovation and business growth. **Indirect** –use the creative power of data and technology to serve London and improve Londoners' lives
20	London's first Smart park	*Aims to collaborating with partners across Europe to deliver smarter, more integrated sustainability solutions*	**Direct** –resource efficient buildings, energy systems, smart living/future living, data architecture and management **Indirect** –measurable environmental, social and economic benefits, these solutions will provide exemplars that can be replicated city-wide or in other districts
21	Tech Map London	*Aims to provide an unprecedentedly detailed picture of London's vibrant science and technology sectors*	**Direct** –a combination of map visualisations, charts and tabular data the platform reveals the massive contribution the sector makes to London's economy **Indirect** –cement the city's status as a global centre for science and technology businesses
22	Smart London Investor Showcase	*Aims to connects all those involved in the angel investment market with a view to ensuring a coherent ecosystem for financing the growth of*	**Direct** –views and interests of the angel investment community to government, opinion formers and business leaders at national, European and international level

		startup and early stage businesses	**Indirect** –ensuring a favourable climate for the continuing support and growth of the angel market across the UK
23	Smart card Oyster	*Aims to create one plastic smartcard which can hold pay as you go credit, Travelcards and Bus & Tram Passes. You can use an Oyster card to travel on bus, Tube, tram, DLR, London Overground, TfL Rail, Emirates Air Line, River Bus services and most National Rail services in London*	**Direct** –ticketing benefits (credit, account, journey history, refund) **Indirect** –journey info data
24	Camden Council – Residents Index	*Aims to unite information from 16 council data sources to create a single, consistent view of residents across the borough and the council services that they are accessing*	**Direct** –have an accurate picture of its citizens and their households provides Camden with a real basis for citizen centric services **Indirect** –customer service innovation, joined up view of their data is helping them to proactively identify potential tenancy fraud
25	Sensing London	*Aims to measure a range of physical parameters, including air quality and human activity*	**Direct** –assess the impact that cities themselves have on human health and understand how people use infrastructures **Indirect** –partners plan to develop new solutions to problems that are really affecting London; new business models that allow our green spaces to prosper in the face of uncertain funding, to providing evidence to justify the business cases for new technologies to improve human health
26	London Living Lab	*Aims to enable experiments to be carried out in situ. It has been established by Intel, the Future Cities Catapult, researchers at ICRI Cities and a collective of local stakeholders in the city*	**Direct** –better understand and design for a range of scenarios and use cases with communities, city officials and stakeholders to help design for the connectedness and sustainability of future cities **Indirect** –how we can we instrument the city without the constraints and cost of a fixed infrastructure
27	London South Bank University (LSBU) – Exceptional Student Experience	*Aims to build on cloud infrastructure to provide a dynamic learning experience for students supported by predictive monitoring of their academic progress to help them achieve their potential*	**Direct** –variety in modes of learning including mobile access to applications, social communities for knowledge sharing, online profiling, and dynamic learning environments **Indirect** –improve teaching, assessment, feedback and student preparation for the world of work
28	Making sensors a commodity	*Aims to find the optimum combination of sensors to detect footfall and other environmental parameters in bus shelters*	**Direct** –sensors are placed in bus stops in and around the Shoreditch area, as well as within buildings **Indirect** –help bus passengers plan their journeys, provide environmental information useful to e.g. asthma sufferers, maximise revenue from advertising in bus stops and optimise bus

			fleet use
29	Programme delivery dashboard for Croydon Council	*Aims to embark on an extensive regeneration programme that in a period of five-years will involve more than 150 construction projects*	**Direct** –£4bn ploughed into extensive regeneration of the town's centre into a vibrant mixed-use district **Indirect** –transform Croydon as a place to live, work and visit
30	Rezatech	*Aims to resolve global business problems caused by environmental change through the scientific analysis of satellite and ground data.*	**Direct** –reduces the costs of quantifying, monitoring and verifying land use change, environmental risk and asset values **Indirect** –help London businesses save time, money and increase accuracy when monitoring their carbon project or a part of supply chain, as well as encouraging investment, from the financial hub that is London, into carbon-reducing projects
31	Tower Bridge Idling	*Aims to measure the air quality when the bridge is raised and the potential for behavioural interventions using targeted, real-time public signage*	**Direct** –data from the sensors plus information from the bridge management system (open / close periods) and traffic data will be used to monitor the impact of vehicles on localised pollution levels **Indirect** –ability to nudge behaviours here provides the evidence to implement this strategy in other locations around the city
32	Imperial College Data Science Institute	*Aims to conduct research on the foundations of data science and to foster the development of advanced theory, technology and systems that contribute to the state-of-the-art in data science and big data*	**Direct** –supports rapid development of applications built on sensor data using data fusion and the integration of models to form novel workflows **Indirect** –development of digital services in a smart city
33	Environmental Performance for Small Businesses	*Aims to bring sustainability to small businesses on their terms. Integrating with accounting platforms companies already in use*	**Direct** –helping London's small businesses get carbon fit, reduce reporting burden and compete globally **Indirect** –low-carbon London; leaner, more profitable and better positioned to take advantage of today's emerging industries
34	Enermap	*Aims to utilize the energy information given in Energy Performance Certificates (EPCs) of buildings.*	**Direct** –online platform that displays the EPCs, along with other energy data in an easy way and with the user in mind **Indirect** –increase consumer awareness on building energy performance, as well as providing tools for both consumers and businesses to make educated decisions for where they choose to live, shop, and work
35	Hyde Park Sensing	*Aims to implement an Environmental Monitoring project focusing on one of the world's great municipal green spaces: London's Hyde Park*	**Direct** –collects unprecedented near real-time data on the park's eco-system and social fabric, and explores how technology can help us manage and experience urban parks in imaginative new

			ways **Indirect** –help quantify the benefits it brings to the city
36	IBM Bluemix Garage	*Aims to helping clients adopt the technologies and practices required to rapidly build innovative mobile & web applications on the cloud*	**Direct** –bring organisations large and small together in an environment of innovation **Indirect** –environment of collaboration and learning through innovation projects
37	IBM and Wimbledon Data and Digital Analytics	*gathers, processes and disseminates real-time data on every point of every match*	**Direct** –provide contextual data that is used to enrich the machine-collected data **Indirect** –fan engagement – delivering a world class experience for the digital user
38	Urban Innovation Centre	*Aims to provide a space for businesses, academics and city leaders from around the world to gather in London, solve urban problems and accelerate their solutions to market*	**Direct** –create real products and services that will be scaled up and used in cities around the world **Indirect** –help cement London's reputation as a hotbed for urban innovation talent
39	Canary Wharf	*Aims to discover, develop and deploy smart cities technologies on the Canary Wharf estate,*	**Direct** –companies to grow their businesses, showcase their technologies and take advantage of the collaborative and supportive working environment **Indirect** –help create efficiencies and convenience in the operation of the estate
40	Future cities Catapult	*Aims to advance urban innovation, to grow UK companies, to make cities better*	**Direct** –bring together businesses, universities and city leaders so that they can work with each other to solve the problems that cities face **Indirect** –turn excellent urban innovations into commercial reality; making innovation happen in cities
41	Smart city opportunities for London- energy	*Aims to improve demand side management through smart metering and energy storage, while encouraging renewable energy production*	**Direct** –Energy sector could have a 16% share of London's total smart city market opportunities, reaching up to $2.1bn **Indirect** –ease regulatory barriers; push live data; develop a clear Internet of Things policy
42	Smart city opportunities for London- smart water management	*Aims to smart solutions in water management for challenges, and the effects of extreme weather conditions, such as heavy rainfall and flooding, as a result of climate change*	**Direct** – data analysis, digital solutions digital innovation, market opportunities **Indirect** –supply and demand management
43	Smart city opportunities for London- smart waste	*Aims to increase the efficiency of collection and separation*	**Direct** –facilitate the transition to a circular economy, whereby valuable and increasingly scarce resources are not wasted **Indirect** – innovation through renewed waste contracts; support to

	management		boroughs; release waste data
44	Smart city opportunities for London-transport	*Aims to offer innovative approaches to analysing data, engaging customers and managing water supply*	**Direct** –Smarter supply and demand management; Data analytics; Smart flood risk management **Indirect** –offer the market a new vehicle to speed up innovation adoption in the UK water sector
45	Smart city opportunities for London-health and assisted living	*Aims to health of citizens for a higher quality of life for all, essential for a productive economy, an affordable healthcare system and a reduced state benefits bill*	**Direct** –Telecare solutions; Solutions addressing ethnic diversity; Accessibility apps; Improving Londoners' health and fitness **Indirect** –Set up co-location space for digital health companies; Create a pathway to market / access to NHS; use telecare to enhance social care
46	Smart city opportunities for London-smart city business	*Aims to bring economic value to London*	**Direct** –Existing innovation ecosystem of digital practitioners and support networks; World-class research and leaders in education; Infrastructure megaprojects; Open data; City-as-a-system initiatives that cut across silos **Indirect** –excellent environment for digital innovators to find the talent they need to thrive

B.3 London Overview of Initiatives according to CityLIFE Actions

LENS	GOAL	ACTION	LONDON INITIATIVES	1	* * *	2	* *	3	*	4	*	5	* * *	6	* *	7	* *	8	* * *	9	* *	10	* * *	11	* * *
				A Smarter London Together		Chief Digital Officer		Smart London Camp 2018		Smart London Board		Working with the boroughs		London Datastore		London Sharing cities		Infrastructure Map		Adam Better Futures		Digital Connectivity		Smart London	
				Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
SOCIETY	Enhance community and individual wellbeing	Promote healthy living and healthy long lives																							
		Increase the match between city dweller aspirations and wellbeing					X		X				X	X			X								
		Minimise ill-being																							
		Maximise cultural benefit			X	X		X				X												X	
	Ensure equity (fairness)	Ensure an enabling physical environment to maximise individual capabilities in the context of carbon reduction and resource security																							
		Ensure an enabling social environment to maximise individual capabilities in the context of carbon reduction and resource security																			X				
		Ensure an enabling economic environment to maximise individual capabilities in the context of carbon reduction and resource security																							
		Ensure an enabling governance environment to maximise individual capabilities in the context of carbon reduction and resource security																							
	Enhance biodiversity and ecosystem services	Minimise the impact of urban density on biodiversity																							
ENVIRONMENT	Ensure resource efficiency	Maximise cultural services (health benefits, recreation, opportunities for outdoor learning)					X								X									X	
		Increase the match between city dwellers' aspirations and resource efficient living					X																		
		Minimise energy use and waste (including heat and CO2 emissions)																						X	
		Increase the match between wellbeing and minimising high-carbon mobilities while maximising low-carbon mobilities and immobilities of people and objects																						X	
		Minimise potable and non-potable water use and waste (including leakage)																						X	
		Minimise food use and waste																							
		Minimise materials use and waste																						X	
		Minimise other waste produced and maximise its reuse, recycling, repurposing																							
		Increase awareness of, and interest in, environmental and climate change issues													X										
	Ensure resource security	Increase the match between city dwellers' aspirations and resource secure living																						X	
		Maximise sustainable use of low-carbon local energy first and then maximise the security of supply of non-local energy																						X	
		Maximise sustainable use of local water first and then maximise the security of supply of non-local water																						X	
		Maximise sustainable use of local food first and then maximise the security of supply of non-local food																							
		Maximise the sustainable use of local materials first and then maximise the security of supply of non-local materials																							
		Maximise sustainable use of local people first (e.g., utilising the local workforce and leveraging local skills) and then maximise the security of supply of non-local people																							
ECONOMY & FINANCE	Maximise sustainable financial investment	Maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO2 emissions)									X										X			X	
	Ensure economic vitality	Uncouple economic vitality from the CO2 emissions associated with economic growth																	X		X				X
GOVERNANCE & POLICY	Ensure appropriate governance	Uncouple governance structures and timescales from political cycles and 'colour' of governing bodies								X															
	Ensure appropriate policies	Uncouple policy making and policy timescales from political cycles and 'colour' of governing bodies			X		X																		
				Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
				0	2	1	4	1	1	1	1	1	1	1	2	0	1	0	1	1	2	0	2	8	1
		Total impact (Direct/Indirect)			2		5		2		2		2		3		1		1		3		2		9
	multiplier	Star rating (***)			6		10		2		2		6		6		2		3		6		6		27

I

12	***	13	***	14	***	15	***	16	***	17	**	18	***	19	***	20	*	21	**	22	**	23	**	24	*	25	***	26	***	27	*	28	*	29
Energy in Buildings		New London Plan		Monitoring and predicting air pollution		Draft Economic strategy		Draft Transport strategy		Digital Talent Programme		Listening exercise for a new Smart London Plan		The Future of Smart (2016)		London's Smart park Sustainable Districts		Tech Map London		Smart London Investor Showcase		Smart card Oyster		Camden Council – Residents Index		Sensing London		London Living Lab		London South Bank University (LSBU)		Making sensors a commodity		Programme delivery dashboard for Croydon Council
Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct
									X						X											X						X	
									X																		X	X					
				X																							X						
					X	X		X			X	X		X		X			X	X								X		X			X
	X							X								X										X					X		
									X								X											X					
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				X	X				X	X			X			X											X		X			X	
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			X																														
X		X		X									X			X										X							
			X		X				X							X			X					X		X							
			X																														
							X				X	X		X			X		X		X					X	X		X				X	X
								X							X			X				X								X			X	
			X				X						X																X					
			X														X									X								
Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct
3	1	3	5	3	4	3	1	3	6	2	1	2	3	2	1	9	5	1	2	2	1	0	1	3	2	5	5	6	2	2	1	1	5	2
	4		8		7		4		9		3		5		3		14		3		3		1		5		10		8		3		6	
	12		24		21		12		27		6		15		9		14		6		6		2		5		30		24		3		6	

II

*	30	* * *	31	*	32	* *	33	* *	34	* * *	35	*	36	*	37	*	38	* *	39	* *	40	* *	41	* *	42	* *	43	* *	44	* *	45	* *	46	* *
	Rostech		Tower Bridge Tilting		Imperial College Data Science Institute		Environmental Performance for Small Business		Enermap		Hyde Park Sensing		IBM Biometric Garage		IBM and Wimbledon Data		Urban Innovation Centre		Canary Wharf		Future cities Catapult		Energy Smart city opportunities for London		Water Management Smart city London		Waste Management Smart city London		Transport Smart city London		Assisted Living Smart city London		Smart City Business	
Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
									X			X																		X			
X				X						X		X																					
																														X			
				X		X	X				X		X			X		X			X										X		X
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		X						X				X		X				X		X		X	X										
	X							X		X			X		X				X			X		X		X			X		X		X	
				X																														
Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
2	4	2	2	3	0	1	3	2	2	4	3	4	2	2	0	1	1	5	1	1	2	1	2	0	1	1	2	1	1	1	2	2	0	2
4		6		5		1		5		6		7		4		1		6		2		3		2		2		3		2		4		2
4		18		5		2		10		18		7		4		1		12		4		6		4		4		6		4		8		4

LENS	GOAL	ACTION	LONDON INITIATIVES	DIRECT ACTIONS	INDIRECT ACTIONS		Three ***	Two **	One *	Multiplier
							Impacts the whole population	Impact to a wider population group	Benefit(s) to only one group	
				TOTAL	TOTAL		16	9	11	418
SOCIETY	Enhance community and individual wellbeing	Promote healthy living and healthy long lives		3	4					
		Increase the match between city dweller aspirations and wellbeing		2	10					
		Minimise ill-being		2	1					
		Maximise cultural benefit		16	10					
	Ensure equity (fairness)	Ensure an enabling physical environment to maximise individual capabilities in the context of carbon reduction and resource security		6	1					
		Ensure an enabling social environment to maximise individual capabilities in the context of carbon reduction and resource security		1	4					
		Ensure an enabling economic environment to maximise individual capabilities in the context of carbon reduction and resource security		1	2					
		Ensure an enabling governance environment to maximise individual capabilities in the context of carbon reduction and resource security		2	1					
	Enhance biodiversity and ecosystem services	Minimise the impact of urban density on biodiversity		5	0					
ENVIRONMENT	Ensure resource efficiency	Maximise cultural services (health benefits, recreation, opportunities for outdoor learning)		5	10					
		Increase the match between city dwellers' aspirations and resource efficient living		1	2					
		Minimise energy use and waste (including heat and CO2 emissions)		4	1					
		Increase the match between wellbeing and minimising high-carbon mobilities while maximising low-carbon mobilities and immobilities of people and objects		4	3					
		Minimise potable and non-potable water use and waste (including leakage)		2	0					
		Minimise food use and waste		0	0					
		Minimise materials use and waste		3	0					
		Minimise other waste produced and maximise its reuse, recycling, repurposing		1	1					
		Increase awareness of, and interest in, environmental and climate change issues		7	4					
	Ensure resource security	Increase the match between city dwellers' aspirations and resource secure living		4	5					
		Maximise sustainable use of low-carbon local energy first and then maximise the security of supply of non-local energy		1	2					
		Maximise sustainable use of local water first and then maximise the security of supply of non-local water		1	0					
		Maximise sustainable use of local food first and then maximise the security of supply of non-local food		0	0					
		Maximise the sustainable use of local materials first and then maximise the security of supply of non-local materials		0	0					
		Maximise sustainable use of local people first (e.g., utilising the local workforce and leveraging local skills) and then maximise the security of supply of non-local people		0	0					
ECONOMY & FINANCE	Maximise sustainable financial investment	Maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO2 emissions)		12	11					
	Ensure economic vitality	Uncouple economic vitality from the CO2 emissions associated with economic growth		7	16					
GOVERNANCE & POLICY	Ensure appropriate governance	Uncouple governance structures and timescales from political cycles and 'colour' of governing bodies		5	3					
	Ensure appropriate policies	Uncouple policy making and policy timescales from political cycles and 'colour' of governing bodies		0	7					
				Direct	Indirect					
				95	98					
		Total impact (Direct/Indirect)			193					
	multiplier	Star rating (***)		Star rating (***)	419					

APPENDIX C STRAND ONE S1 COPENHAGEN

C. 1 Initiatives & Initiations

COPENHAGEN INITIATIVES & INITIATORS					
ID	**Copenhagen Initiative**		**Source**	**Initiators**	**Reach**
1.	People and flows	*to make the urban development smarter and based on data to a greater extent (resource security, pedestrian, cyclists, citizen participation)*	https://cphsolutionslab.dk/en/what-we-do/themes/people-and-flows	Copenhagen Solutions Lab	**A**
2.	Data Driven Operation and Supervision	*development of operational and supervisory tasks, departments to identify the potential of the operation, aim of providing better and more focussed services to city residents*	https://cphsolutionslab.dk/en/what-we-do/themes/data-driven-operations	Copenhagen Solutions Lab	**A**
3.	Environment and Climate	*new types of data can complement existing models with nuanced information about local conditions, so the efforts can be optimized- reduce CO2 emissions and ensure energy optimisation*	https://cphsolutionslab.dk/en/what-we-do/themes/climate-monitoring	Copenhagen Solutions Lab	**A**
4.	Lighting and Urban Life	*increased security and safety in traffic-better experience and availability of the city's offerings, including cultural and recreational institutions*	https://cphsolutionslab.dk/en/what-we-do/themes/light-and-urban-life	Copenhagen Solutions Lab	**A**
5.	Street Lab	*a laboratory in the city centre where - test new solutions under real urban conditions, for their potential and limitations, assess what can be scaled to larger areas of the city*	https://cphsolutionslab.dk/en/what-we-do/labs/street-lab	Copenhagen Solutions Lab	**A**
6.	Energy Block	*a testing area for sustainable solutions based on decentralized energy and blockchain technology- investigate and demonstrate the potential of the use of renewable energy sources in the real urban environment*	https://cphsolutionslab.dk/en/what-we-do/labs/energyblock	Copenhagen Solutions Lab	**A**
7.	Underbroen	*a community for innovators to engage in knowledge-sharing and debate about digital*	https://cphsolutionslab.dk/en/what-we-do/labs/underbroen	Copenhagen Solutions Lab	**A**

		prototyping and production, small businesses, start-ups and organisations try out digital production technologies, design thinking, prototyping and development of product ideas			
8.	Open Data DK	*an association that consists of a number of Danish municipalities and regions, aims to make government data open and available for use by citizens and businesses,improve transparency in public administration and support data-driven growth*	https://cphsolutionslab.dk/en/what-we-do/data-platforms/open-data	Copenhagen Solutions Lab	**A**
9.	Select for Cities	*create a new and innovative IoT platform for cities-offers companies funding for developing prototypes and testing them in real-world conditions*	https://cphsolutionslab.dk/en/what-we-do/data-platforms/iot-platform-for-cities & http://www.select4cities.eu/city-use-cases-1	Copenhagen Solutions Lab	**A**
10	City Data Exchange	*a private/public collaboration to examine the private/public data exchange- purchasing, selling and sharing a broad range of data types between all kinds of users in a city – citizens, public institutions and private companies*	https://cphsolutionslab.dk/en/what-we-do/data-platforms/city-data-exchange	Copenhagen Solutions Lab Hitachi	**A**
11	A Living Healthtech Lab	*health data registries, along with a state-of-the-art hospital sector and healthcare system, for health technology testing and innovation*	http://www.copcap.com/invest-in-greater-copenhagen/investment-opportunities/a-living-healthtech-lab	Copenhagen Capacity	**A**
12	World's first Carbon Neutral Capital	*aiming to become the first carbon-neutral capital by 2025, Copenhagen is a frontrunner in green transformation, renewable energy, upcycling and recycling, green mobility and smart city solutions*	http://www.copcap.com/invest-in-greater-copenhagen/investment-opportunities/copenhagen-carbon-neutral-2025	Copenhagen Capacity	**A**
13	Scandinavian's most cost-efficient capital (20% cheaper than Stockholm)	*business operating costs are lower in Copenhagen than in the other Nordic capitals, Stockholm, Oslo and Helsinki*	http://www.copcap.com/invest-in-greater-copenhagen/investment-opportunities/cheaper-than-stockholm	Copenhagen Capacity	**A**
14	Smart City in Copenhagen Leading Smart City	*new smart city technologies / solutions are being tested and developed across the ICT, cleantech, construction and transportation sectors-strong*	http://www.copcap.com/set-up-a-business/key-sectors/smart-city	Copenhagen Capacity	**A**

		political focus on sustainable societies			
15	Pharma logistics and supply change	*gateway to fast and cost-efficient pharmaceuticals and biotech cool chain in Europe- Greater Copenhagen is Northern Europe's hub for pharma logistics and supply chain*	http://www.copcap.com/invest-in-greater-copenhagen/investment-opportunities/pharma-logistics-and-supply-chain	Copenhagen Capacity	**A**
16	HealthCare	*cleantech hub for green investment and innovation Copenhagen's cleantech cluster excels in smart city and smart grid, renewable energy, water and waste management as well as recycling and upcycling technologies*	http://www.copcap.com/set-up-a-business/key-sectors/cleantech	City of Copenhagen	**A**
17	Healthtech	*connects businesses, municipalities and regions and bring them together to develop and implement digital healthcare solutions*	http://www.cphhealthtech.com/about	City of Copenhagen	**A**
18	Creative Cluster	*development of industrial clusters, strengthening dialogue with the business community, and building partnerships with commercial and knowledge institutions*	https://international.kk.dk/artikel/sustainable-city-initiatives	City of Copenhagen	**A**
19	Framework improvements for construction sector	*develop strategy for energy consumption in construction sector, develop and test funding model for realisation of energy savings, work to change legislation to facilitate more energy efficiency*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p16	The City of Copenhagen Technical and Environmental Administration Roadmap	**A**
20	Energy efficient buildings in Copenhagen	*establish method, guidelines and target funds for increasing climate retrofitting, establish method and framework to ensure coherence between projected and actual energy consumption, promote development of technology and solutions to secure low-energy new build, regulation of heat and domestic water supplies Develop, test and implement model for energy savings in commercial and service companies*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p16	The City of Copenhagen Technical and Environmental Administration Roadmap	**A**
21	Proliferation of solar cells	*motivate and support proliferation of solar cells*	https://stateofgreen.com/en/profiles/city-of-	The City of Copenhagen	**A**

			copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p16	Technical and Environmental Administration Roadmap	
22	Innovation and profiling	*knowledge building and experience sharing Establish partnerships for setting up private lighthouse projects*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p16	The City of Copenhagen Technical and Environmental Administration Roadmap	**A**
23	The smart city	*establish digital infrastructure for public data support, increased flexible energy consumption disseminate concept of smart house solutions improve framework for use of onshore electricity on cruise liners energy production, power generation based on wind and biomas ,separation of plastic - domestic and commercial, biogasification of organic waste land wind turbines*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p16	The City of Copenhagen Technical and Environmental Administration Roadmap	**A**
24	Land wind turbines - within city of Copenhagen	*identification of 4 sites in Copenhagen with room for 14 wind turbines planning process for a total of 7 wind turbines expected to be concluded in 2013*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p16	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
25	Wind turbines - other municipalities	*negotiations with land owners on possible sites*	kk.sites.itera.dk/apps/kk_pub2/pdf/983_jkP0ekKMyD.pdf p16	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
26	Offshore wind turbines	*encourage the Government to lay down settlement model for offshore wind turbines, installation of offshore wind turbines on 2 predetermined sites, bidding partnership for state wind turbine project*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p16	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
27	Bidding partnership for state wind turbine	*examine possibilities for establishing tendering partnerships in relation to offshore wind turbine*	https://stateofgreen.com/en/profiles/city-of-	CPH 2025 Climate Plan	**A**

	projects	*projects*	copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p16	A Green, Smart, & Carbon Neutral City	
28	Biomass in combined heat and power plants	*draft decision-making basis regarding the establishment of wood-fired combined heat and power plant, negotiations on the conversion to biomass on amager and avedøre combined heat and power plants*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p16	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
29	New heat generation units in Copenhagen	*draft decision-making basis regarding the establishment of geothermal plant draft decision-making and time line for the establishment of renewable heat production units incl. heat pump, heat storage and solar heating*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p16	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
30	Conversion of peak production to carbon neutral fuels	*analyse possibilities for converting peak load production*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p16	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
31	New waste treatment centre	*draft decision-making basis regarding the establishment of new waste incineration plant*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p16	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
32	Treatment of organic waste	*assessment of renescience plant and other treatment technologies for biogasification of organic waste, examination of various methods of organic waste collection*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p16	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
33	Separation of plastic from waste	*set up arrangement for collecting for hard plastic clarify methods for prevention, separation and reuse of plastic*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p16	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**

34	City of Cyclists	*develop cycle connections to and develop partnerships and green growth for cycling establish partnerships with 300 - 600 companies about using electric cycles develop concept of improved conditions for cycling with the aim of promoting cycling in 600 - 1,000 private companies*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p18	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
35	New fuels in transport sector (power, hydrogen, biofuels)	*demonstration projects using new fuels for light and heavy transport establish infrastructure for vehicles using new fuels initiate collaboration and joint ventures with relevant players*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p18	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
36	Public transport	*develop and start demonstration projects using new fuels for busses improve public infrastructure by implementing City Net 2018*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p18	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
37	Intelligent Traffic Systems	*plan for monitoring traffic management leading to improved traffic flow establish a system for joint traffic management leading to improved traffic information optimisation of signalling installations to facilitate better traffic flow and improved possibility for buses increase of ecodriving*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p18	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
38	Mobility planning	*establish mobility programme to alter transport conduct long-term 'attitude training'*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p18	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
39	Systematic consumption mapping and energy management	*establish remote meter reading and systems to register energy consumption establish organisation to assess development of consumption secure energy management and energy efficient operations*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p18	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
40	Energy efficient buildings	*continue the municipal energy savings fund implement all energy saving initiatives with a short payback time climate retrofitting of all city of*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-	CPH 2025 Climate Plan A Green, Smart,	**A**

		Copenhagen properties new buildings to be constructed with climate adaptations and low energy use secure energy efficiency in private rented accommodation and other non-municipal properties by consumption regulations	carbon-neutral-by-2025 p18	& Carbon Neutral City	
41	Solar cells installed on City of Copenhagen properties	*create lighthouse projects within climate retrofitting and climate-adapted new build*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p18	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
42	Switching of car fleet to new fuels	*develop and implement a transition plan implement management system establish infrastructure for electric charging stations establish pilot and demonstration projects for fuel technologies for heavy vehicles determine regulations for the use of new fuels for external driving*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p18	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
43	Procurement	*implement procurement strategies with focus on transport, energy consuming products and the construction sector*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p18	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
44	Behaviour and training	*secure climate-friendly conduct by city employees in the areas of consumption, transport and purchasing by means of courses and info meetings*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p18	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
45	Energy-efficient street lighting	*replace street lighting*	https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025 p18	CPH 2025 Climate Plan A Green, Smart, & Carbon Neutral City	**A**
46	Project Management WP1	*secure optimal execution of the project by managing the project effectively and professionally, this includes management of risks, secure efficient communication and support transparent decision-*	http://energylabnordhavn.dk/	Energy Lab Nordhavn	**A**

		making processes of the consortium			
47	Data and Measurements WP2	*establish and operate a data collection and management system for EnergyLab Nordhavn integrated in PowerLabDK providing real-time and historic data from all energy infrastructures (electricity, heating, and transport)*	http://energylabnordhavn.dk/	Energy Lab Nordhavn	**A**
48	Smart Energy Buildings WP3	*new understanding of low-energy buildings as active energy-flexible elements in a smart energy system, develop and showcase associated novel control solutions for smarter operation and monitoring of energy in modern buildings transforming challenging fluctuations of the various energy forms into an interconnected system*	http://energylabnordhavn.dk/	Energy Lab Nordhavn	**A**
49	Smart Network Services WP4	*develop, experimentally verify and evaluate various control-based enabling technologies and solutions for smart networks services with high cost and energy efficiency and business potential, provide elements for a smart energy infrastructure design and operation*	http://energylabnordhavn.dk/	Energy Lab Nordhavn	**A**
50	District heating infrastructures WP5	*develop district heating designs for dense, low-energy and low-temperature district heating areas, employ measures to create increased flexibility by heat storage in pipelines and buildings, to make the flexibility potential of district heating accessible for the electricity system*	http://energylabnordhavn.dk/	Energy Lab Nordhavn	**A**
51	Electricity infrastructure WP6	*flexible and dynamic consumption patterns, new grid designs, innovative add-ons to the current grid layout will be developed and evaluated for grid performance and financial feasibility*	http://energylabnordhavn.dk/	Energy Lab Nordhavn	**A**
52	Electric transportation Infrastructure WP7	*develop and experimentally verify robust and cost-effective smart charging solutions for electric transportation in dense areas, and how these can contribute intelligently to an overall optimized energy system*	http://energylabnordhavn.dk/	Energy Lab Nordhavn	**A**

53	Multi-carrier Energy Systems Operation and Markets WP8	*develop, experimentally validate and evaluate the integration of the various energy infrastructures,solutions will cover integrated market design for heat and electricity markets as well as operational control room solutions to function across energy infrastructures*	http://energylabnordhavn.dk/	Energy Lab Nordhavn	**A**
54	Visibility and Stakeholder Engagement WP9	*ensure stakeholder engagement, support dissemination of the project results in Nordhavn, and utilize the visibility of Nordhavn and the EnergyLab Nordhavn project to support an associated SME innovation in Nordhavn*	http://energylabnordhavn.dk/	Energy Lab Nordhavn	**A**
55	Smart components in integrated energy systems WP10	*demonstrates and analyses the technical and economic feasibilities of smart control of specific components and systems, main functions to provide heat and cooling services in buildings, including space heating, hot tap water and food cooling*	http://energylabnordhavn.dk/	Energy Lab Nordhavn	**A**
56	Copenhagen Open Value Network	*create visibility and accessibility to data, connect private and public data owners, data consumers and innovators, and create common technical and business standards for data exchange,also drive new solutions that enable the City to achieve its 2025 Climate Plan objectives and foster innovation and growth*	http://prd-ibm-smarter-cities-challenge.s3.amazonaws.com/applications/copenhagen-denmark-2013-full-report.pdf p21	IBM Smarter Cities Challenge Copenhagen	**C**
57	Integrated end-to-end energy model	*integrated thermodynamic/electrical performance of each grid: electric, district heating, cooling, water, traffic, the influence of weather, economic inputs, including market prices of fuels and the cost of capital to support future energy investments*	http://prd-ibm-smarter-cities-challenge.s3.amazonaws.com/applications/copenhagen-denmark-2013-full-report.pdf p32	IBM Smarter Cities Challenge Copenhagen	**C**
58	Transportation and Building Initiatives	*recommendation will affect public and private consumers:* *buildings: public buildings, excluding preserved heritage buildings, private buildings, including commercial complexes, individually owned, social housing sector buildings, pilot in the areas of sankt kjelds quarter and north harbor to validate and*	http://prd-ibm-smarter-cities-challenge.s3.amazonaws.com/applications/copenhagen-denmark-2013-full-report.pdf p40	IBM Smarter Cities Challenge Copenhagen	**C**

		optimize energy efficiency recommendations traffic: private and public transportation, all means of transportation			
59	Governance Body	*own and manage processes, initiatives and associated projects that will move copenhagen to 100% carbon neutrality by 2025.governance body's responsibility to drive better decisions and collaboration across the matrix of stakeholders, including government, business and citizens*	http://prd-ibm-smarter-cities-challenge.s3.amazonaws.com/applications/copenhagen-denmark-2013-full-report.pdf p45	IBM Smarter Cities Challenge Copenhagen	**C**

C. 2 Benefits & Impacts

1. COPENHAGEN BENEFITS & IMPACTS			
ID	**Copenhagen Initiative**	**Aims and Intended Benefits**	**Impacts (Direct and Indirect Benefit)**
1.	People and flows	*Aims to create the best urban spaces based on the way people use the city*	**Direct** –make the urban development smarter and based on data to a greater extent (mobility data)-use resources in the best way **Indirect** –data to determine the effect of measures on business, tourism and urban life
2.	Data Driven Operation and Supervision	*Aims to the development of operational and supervisory tasks*	**Direct** –work with the departments to identify the potential of the operation **Indirect** –rethinking the way services are performed city services for citizens
3.	Environment and Climate	*Aims to new types of data can complement existing models with nuanced information about local conditions, so the efforts can be optimized*	**Direct** –monitoring can help identify the environmental impact of municipal actions in the long term, and thus qualify political decisions **Indirect** –find new ways to reduce CO2 emissions and ensure energy optimisation
4.	Lighting and Urban	*Aims to ensure visibility and light up streets and urban*	**Direct** –security and safety in traffic; Better experience and

	Life	*spaces*	availability of the city's offerings, including cultural and recreational institutions **Indirect** –increase quality of life
5.	Street Lab	*Aims to test the solutions for their potential and limitations, so we can assess what can be scaled to larger areas of the city*	**Direct** –solutions in areas such as smart parking, care of urban nature, waste management and measurement of air quality **Indirect** –to be one step ahead of city operations and services for Copenhageners
6.	Energy Block	*Aims to investigate and demonstrate the potential of the use of renewable energy sources in the real urban environment*	**Direct** –testing area for sustainable solutions **Indirect** –decentralized energy and blockchain technology
7.	Underbroen	*Aims to combine traditional craftsmanship with modern digital production technologies*	**Direct** –gives small businesses, start-ups and organisations the chance to learn about and try out digital production technologies, design thinking, prototyping and development of product ideas **Indirect** –gives Copenhagen Municipality the opportunity to work with the development of prototypes for future urban equipment
8.	Open Data DK	*Aims to make government data open and available for use by citizens and businesses*	**Direct** –data about the city contains information on infrastructure, traffic, cultural events (and more) **Indirect** –improve transparency in public administration and support data-driven growth
9.	Select for Cities	*Aims to create a new and innovative IoT (Internet of Things) platform for cities*	**Direct** –offers companies funding for developing prototypes and testing them in real-world conditions **Indirect** –prototypes to lead to the future purchase of IoT platforms in European cities
10	City Data Exchange	*Aims to establish a citywide data marketplace, City Data Exchange, for data owned by public authorities and private companies*	**Direct** –a shared data hub to foster innovation and inspire new thinking that will improve the quality of life in the Copenhagen area, stimulate business activity, and help to achieve Copenhagen's goal to be carbon neutral by 2025 **Indirect** –private/public data exchange and collaboration
11	A Living Healthtech Lab	*Aims to deliver new healthtech solutions to address the health challenges that come with modern society*	**Direct** –innovative solutions within telemedicine, e-health, assistive technology, homecare and digital healthcare are core focus areas in Greater Copenhagen **Indirect** –offering business opportunities for solution

			providers in the public and private healthcare sectors
12	World's first Carbon Neutral Capital	*Aims to become the first carbon-neutral capital by 2025*	**Direct** –green transformation, renewable energy, upcycling and recycling, green mobility and smart city solutions **Indirect** –green growth strategy
13	Scandinavian's most cost-efficient capital (20% cheaper than Stockholm)	*Aims to lower business operating costs in Copenhagen than in the other Nordic capitals, Stockholm, Oslo and Helsinki*	**Direct** – 15-20% cheaper than Stockholm in terms of total costs of operating a Scandinavian headquarters or a shared services centre for IT, HR, R&D, supply chain, finance or customer support **Indirect** –regional headquarters in Copenhagen: low cost and high quality
14	Smart City in Copenhagen Leading Smart City	*Aims to handle the challenges of urbanisation and climate change*	**Direct** –technologies and solutions are being tested and developed across the ICT, cleantech, construction and transportation sectors **Indirect** –assist international companies looking for business partners, investment opportunities and test markets for new products and technologies
15	Pharma logistics and supply change	*Aims to become the gateway to fast and cost-efficient pharmaceuticals and biotech cool chain in Europe*	**Direct** –hub for pharma logistics and supply chain **Indirect** –(n/a)
16	HealthCare	*Aims to green investment and innovation*	**Direct** –smart city and smart grid, renewable energy, water and waste management as well as recycling and upcycling technologies **Indirect** –lead position in innovation, prompted by state incentives and ambitious regulation
17	Healthtech	*Aims to contribute to the political agenda concerned with the establishment of* Healthy Growth– *better healthcare in the public healthcare sector and growth for businesses that develop solutions, that can deal with future healthcare challenges*	**Direct** –smarter and more cost-effective healthcare solutions **Indirect** –strives to accelerate this development by offering decision makers municipalities and regions an overview of digital healthcare solutions available on a national and global scale
18	Creative Cluster	*Aims to the development of industrial clusters, i.e. existing commercial areas that have a competitive advantage*	**Direct** –focus is on the Cleantech, Healthtech and the Creative clusters **Indirect** –strengthening dialogue with the business community, and by building partnerships with both commercial and knowledge institutions

19	Framework improvements for construction sector	*Aims to develop strategy for energy; develop and test funding model; work to change legislation*	**Direct** –energy consumption in construction sector; energy savings; energy efficiency **Indirect** –
20	Energy efficient buildings in Copenhagen	*Aims to establish method and guidelines and target funds; establish method and framework; promote development of technology and solutions; adequate regulation of heat and domestic water supplies develop, test and implement model*	**Direct** –increasing climate retrofitting; energy consumption; secure low-energy in new build; heat and domestic water supplies; for realising energy savings in commercial and service companies **Indirect** –
21	Proliferation of solar cells	*Aims to motivate and support*	**Direct** – proliferation of solar cells **Indirect** –
22	Innovation and profiling	*Aims to build knowledge and experience sharing; establish partnerships*	**Direct** – setting up private lighthouse projects **Indirect** –
23	The smart city	*Aims to establish digital infrastructure; support an increased flexible energy consumption; disseminate concept; local hydrogen production; improve framework*	**Direct** –public data; energy consumption; smart house solutions; hydrogen production; onshore electricity on cruise liners **Indirect** –
24	Land wind turbines - within city of Copenhagen	*Aims to identify 4 sites; planning process*	**Direct** –14 wind turbines; 7 wind turbines **Indirect** –
25	Wind turbines - other municipalities	*Aims to negotiate with land owners*	**Direct** – possible sites **Indirect** –
26	Offshore wind turbines	*Aims to encourage the Government; installation*	**Direct** –lay down favourable settlement model f **Indirect** –
27	Bidding partnership for state wind turbine projects	*Aims to examine possibilities*	**Direct** –tendering partnerships **Indirect** –
28	Biomass in combined heat and power plants	*Aims to draft decision-making basis; negotiations*	**Direct** –establishment of wood-fired combined heat and power plant; conversion to biomass on Amager and Avedøre combined heat and power plants **Indirect** –
29	New heat generation units in Copenhagen	*Aims to draft decision-making basis; draft decision-making and time line*	**Direct** –geothermal plant; establishment of renewable heat production units incl. heat pump, heat storage and solar heating **Indirect** –

30	Conversion of peak production to carbon neutral fuels	*Aims to analyse possibilities for energy and waste*	**Direct** – low carbon **Indirect** –
31	New waste treatment centre	*Aims to draft decision-making*	**Direct** –establishment of new waste incineration plant **Indirect** –
32	Treatment of organic waste	*Aims to assess REnescience plant and other treatment technologies; examination of various methods of organic waste collection*	**Direct** –biogasification of organic waste; organic waste collection **Indirect** –
33	Separation of plastic from waste	*Aims to set up arrangement; clarify methods for prevention, separation and reuse of plastic*	**Direct** –collecting for hard plastic; prevention, separation and reuse of plastic **Indirect** –
34	City of Cyclists	*Aims to develop cycle connections; partnerships and green growth; establish partnerships; promote cycling*	**Direct** –Develop cycle connections to and from Copenhagen; develop partnerships and green growth for cycling; establish partnerships with 300 - 600 companies about using electric cycles; develop concept of improved conditions for cycling with the aim of promoting cycling in 600 - 1,000 private companies **Indirect** –
35	New fuels in transport sector (power, hydrogen, biofuels)	*Aims to develop and start demonstration projects; establish infrastructure for vehicles; initiate collaboration and joint ventures; work to ensure that the Government secures a long-term charging structure*	**Direct** –using new fuels for light and heavy transport; using new fuels; ventures with relevant players; favouring cars using new fuels **Indirect** –
36	Public transport	*Aims to develop and start demonstration projects; improve public infrastructure; energy efficient operation*	**Direct** –new fuels for busses; implementing CityNet 2018; Metro and S-train operation **Indirect** –
37	Intelligent Traffic Systems	*Aims to establish a plan; establish a system for joint traffic management; optimisation of signalling installations; passability for buses; offering courses*	**Direct** –improved traffic flow; improved traffic information; facilitate better traffic flow and improved passability for buses increase of ecodriving **Indirect** –
38	Mobility planning	*Aims to offer courses; mobility planning; mobility programme; long-term 'attitude training'*	**Direct** –increase of ecodriving; alter transport conduct **Indirect** –
39	Systematic consumption mapping and energy management	*Aims to establish remote meter reading and systems; establish organisation; secure energy management and energy efficient operations*	**Direct** –register energy consumption; assess development of consumption; permanent and integrated part of operations **Indirect** –

40	Energy efficient buildings	*Aims to continue the Municipal Energy Savings Fund implement all energy saving initiatives; retrofitting; new buildings; secure energy efficiency; create lighthouse projects within climate retrofitting and climate-adapted new build*	**Direct** –short payback time; City of Copenhagen properties new buildings to be constructed with climate adaptations and low energy use; consumption regulations; retrofitting and climate-adapted new build **Indirect** –
41	Solar cells installed on City of Copenhagen properties	*Aims to establish solar cells*	**Direct** –City of Copenhagen properties **Indirect** –
42	Switching of car fleet to new fuels	*Aims to develop and implement a transition plan; implement management system; establish infrastructure; establish pilot and demonstration projects ; determine regulations*	**Direct** –electric charging stations; fuel technologies for heavy vehicles; use of new fuels for external driving **Indirect** –
43	Procurement	*Aims to implement procurement strategies*	**Direct** –transport, energy consuming products and the construction sector **Indirect** –
44	Behaviour and training	*Aims to secure climate-friendly conduct*	**Direct** –consumption, transport and purchasing by means of courses and info meetings **Indirect** –
45	Energy-efficient street lighting	*Aims to replace lighting*	**Direct** –street lighting **Indirect** –
46	Project Management WP1	*Aims to secure optimal execution of the project; secure efficient communication; support transparent decision-making; support the operation of the project advisory board*	**Direct** – management of risks; support effective dissemination of the project; deliver the project final report **Indirect** –
47	Data and Measurements WP2	*Aims to establish and operate a data collection and management system for EnergyLab;*	**Direct** –source for characterisation, analysis and development of new smart energy solutions for large, dense and low-energy city areas; provide basis for a real-time public accessible visualisation **Indirect** –data warehouse and control room solution established in PowerLabDK; benefit of the existing SCADA and control room infrastructure; considering privacy issues
48	Smart Energy Buildings WP3	*Aims to provide a new understanding of the possibilities that arise from using low energy buildings of Nordhavn - including occupants and users - as active components in the future smart energy system*	**Direct** –development and verification of smart energy building models and simulations; design of predictive controllers; implementation and operation of the controls developed

			Indirect –energy-flexible elements in a smart energy system
49	Smart Network Services WP4	*Aims to develop, verify and evaluate control-based enabling technologies and solutions for smart networks services*	**Direct** –high cost and energy efficiency and promising business potential; provide elements for smart energy infrastructure **Indirect** –smart energy design and operation
50	District heating infrastructures WP5	*Aims to develop district heating designs; employ measures; communication between buildings' heating systems and the supply network; potential of district heating*	**Direct** –low-energy and low-temperature district heating areas; increased flexibility by heat storage in pipelines and buildings; flexibility potential of district heating accessible for the electricity system **Indirect** –
51	Electricity infrastructure WP6	*Aims to investigate flexible and dynamic consumption patterns and new grid designs; add-ons to the current grid layout will be developed and evaluated for grid performance and financial feasibility*	**Direct** –Prediction to be stochastic; project attempt to develop a method to cope; grid design philosophy to cope with the stochastic nature of the load and may be a less isolated technical task **Indirect** –strategies and operation conditions for an installed battery with a view to provide services in relation to the above mentioned issues
52	Electric transportation Infrastructure WP7	*Aims to develop a robust and cost-effective smart charging solutions*	**Direct** – electric transportation in dense areas **Indirect** –optimized energy system
53	Multi-carrier Energy Systems Operation and Markets WP8	*Aims to integrate the various energy infrastructures*	**Direct** –integrated market design for heat and electricity markets; operational control room **Indirect** –energy infrastructures
54	Visibility and Stakeholder Engagement WP9	*Aims to ensure stakeholder engagement; support the dissemination of the project results in Nordhavn;*	**Direct** –utilize the visibility of Nordhavn and the EnergyLab Nordhavn project **Indirect** –support an associated SME innovation in Nordhavn
55	Smart components in integrated energy systems WP10	*Aims to demonstrates and analyses the technical and economic feasibilities of smart control*	**Direct** –providing space heating and domestic hot water for multifamily or commercial buildings; regulation of a water based building space heating; utilization of spare heat pump capacity for a supermarket. **Indirect** –economic

56	Copenhagen Open Value Network	*Aims to create visibility and accessibility to data, connect private and public data owners, data consumers and innovators, and create common technical and business standards for data exchange*	**Direct** –allow the City to realize better outcomes; lower risk from climate plan initiatives; early forecasts; executing the climate plan initiatives; new climate plan initiatives; enable new initiatives data available for climate plan initiatives; value from insight, energy technologies and business innovations **Indirect** –new solutions that enable the City to achieve its 2025 Climate Plan objectives and foster innovation and growth
57	Integrated end-to-end energy model	*Aims to the integrated thermodynamic/electrical performance of each grid*	**Direct** –electric, district heating, cooling, water, traffic, the influence of weather (historical, real time and forecasts), as well as economic inputs, including market prices of fuels and the cost of capital to support future energy investments **Indirect** –interlocking models of energy consumption, production and emissions
58	Transportation and Building Initiatives	*Aims to develop recommendation will affect public and private consumers*	**Direct** –Buildings; Traffic; data sources; applications data integrated, modeled, aggregated, visualized and shared that provides new insight; free current data; monitor the pilot; collaborate with Open Value Network; create citizen driven, innovative applications; develop a 3D visual model (heat map) of energy, heating and CO2 emissions; visual flow model of energy consumption and CO2 emissions from traffic traffic and building programs rolled; evolve energy consumption model and plan recognition program for energy efficient buildings and sustainable traffic; continue to run the media campaigns (reinforce energy efficiency messages for behavioural change; energy savings a high priority with consumers; connect CO2 emissions to health hazards; communication with the schools and colleges; lower energy taxes; taxation as an incentive for adaptation of CO2 neutral initiatives; guarantee loans on initiatives for lowering energy consumption and CO2 emissions; tax cut for the retrofitting of old buildings

			Indirect –huge potential to bring in substantial savings to all stakeholders
59	Governance Body	*Aims to establish a governance and innovation structure, under the direction of the Lord Mayor's appointed leader, with clearly defined leadership, to drive strategy, joint matrix management oversight and system performance*	**Direct** –value to stakeholders; implementation of sponsored transformation and innovation initiatives; economic growth • 100% carbon neutrality by 2025; reduction in energy consumption; alignment of data regarding ownership, standards, exchange algorithms, openness, privacy and structure **Indirect** –integrated data solutions, thereby inhibiting optimization of the full benefit potential

C.3 Copenhagen Overview of Initiatives according to CityLIFE Actions

LENS	GOAL	ACTION	COPENHAGEN INITIATIVES	1 People and flows * * *		2 Data Drives Operation and Supervision * * *		3 Environment and Climate * * *		4 Lighting and Urban Life * * *		5 Street Lab *		6 Energy Block *		7 Underbroen * *		8 Open Data DK * *		9 Smart for Cities * *		10 City Data Exchange * *		11 Healthtech Lab * *	
				Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
SOCIETY	Enhance community and individual wellbeing	Promote healthy living and healthy long lives			X						X		X														X
		Increase the match between city dweller aspirations and wellbeing				X																		X			
		Minimise ill-being																									X
		Maximise cultural benefit			X					X																	
	Ensure equity (fairness)	Ensure an enabling physical environment to maximise individual capabilities in the context of carbon reduction and resource security		X											X												
		Ensure an enabling social environment to maximise individual capabilities in the context of carbon reduction and resource security		X																				X			
		Ensure an enabling economic environment to maximise individual capabilities in the context of carbon reduction and resource security																						X			
		Ensure an enabling government environment to maximise individual capabilities in the context of carbon reduction and resource security				X			X																		
	Enhance biodiversity and ecosystem services	Minimise the impact of urban density on biodiversity																									
ENVIRONMENT	Ensure resource efficiency	Maximise cultural services (health benefits, recreation, opportunities for outdoor learning)								X														X			
		Increase the match between city dwellers' aspirations and resource efficient living																						X			
		Minimise energy use and waste (including heat and CO2 emissions)							X															X			
		Increase the match between wellbeing and minimising high-carbon mobilities while maximising low-carbon mobilities and immobilities of people and objects		X				X		X			X														
		Minimise potable and non-potable water use and waste (including leakage)						X																			
		Minimise food use and waste																									
		Minimise materials use and waste																									
		Minimise other waste produced and maximise its reuse, recycling, repurposing										X															
		Increase awareness of, and interest in, environmental and climate change issues													X												
	Ensure resource security	Increase the match between city dwellers' aspirations and resource secure living															X										
		Maximise sustainable use of low-carbon local energy first and then maximise the security of supply of non-local energy																						X			
		Maximise sustainable use of local water first and then maximise the security of supply of non-local water																									
		Maximise sustainable use of local food first and then maximise the security of supply of non-local food																									
		Maximise the sustainable use of local materials first and then maximise the security of supply of non-local materials																									
		Maximise sustainable use of local people first (e.g., utilising the local workforce and leveraging local skills) and then maximise the security of supply of non-local people																									
ECONOMY & FINANCE	Maximise sustainable financial investment	Maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO2 emissions)			X																	X		X		X	
	Ensure economic vitality	Uncouple economic vitality from the CO2 emissions associated with economic growth																						X		X	
GOVERNANCE & POLICY	Ensure appropriate governance	Uncouple governance structures and timescales from political cycles and 'colour' of governing bodies					X										X		X								
	Ensure appropriate policies	Uncouple policy making and policy timescales from political cycles and 'colour' of governing bodies																									
				Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
				3	3	2	1	4	2	3	1	2	1	2	0	1	1	0	1	1	0	7	2	2	2		
		Total impact (Direcrt/Indirect)			6		3		6		3		3		2		2		1		1		9		4		
	multiplier	Star rating (***)			18		9		18		9		3		2		4		2		2		18		8		

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World's first Carbon Neutral Capital				Scandinavia's most cost-efficient capital				Copenhagen Leading Smart City				Pharma logistics and supply change				HealthCare				Bioethics				Creative Cluster				Framework improvements for construction sector				Energy efficient buildings in Copenhagen				Proliferation of solar cells				Innovation and profiling				The smart city				Land wind turbines Copenhagen				Wind turbines - other municipalities				Offshore wind turbines				Bidding partnership for state wind turbine		
Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect	
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Biomass in combined heat and power plants		Heat generation Copenhagen		Conversion of peak production to carbon neutral fuels		New waste treatment centre		Treatment of organic waste		Separation of plastic from waste		City of Cyclists		New fuels in transport sector		Public transport		Intelligent Traffic Systems		Mobility planning		Systematic consumption / energy management		Energy efficient buildings		Solar cells installed on Copenhagen		Switching of car fleet to new fuels		Procurement	
Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
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Behaviour and training				Energy-efficient street lighting				Project Management				Data and Measurements				Smart Energy Building				Smart Network Services				District heating infrastructures				Electricity infrastructure				Electric transportation infrastructure				Multi-carrier Energy				Visibility and Stakeholder Engagement				Smart components in energy systems				Copenhagen Open Value Network				Integrated end-to-end energy model				Transportation and Building Initiatives				Governance Body			
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LENS	GOAL	ACTION	COPENHAGEN INITIATIVES	DIRECT ACTIONS	INDIRECT ACTIONS		Three ***	Two **	One *	Multiplier
							Impacts the whole population	Impact to a wider population group	Benefit(s) to only one group	
				TOTAL	TOTAL		24	32	3	566
SOCIETY	Enhance community and individual wellbeing	Promote healthy living and healthy long lives		6	4					
		Increase the match between city dweller aspirations and wellbeing		3	0					
		Minimise ill-being		5	1					
		Maximise cultural benefit		3	1					
	Ensure equity (fairness)	Ensure an enabling physical environment to maximise individual capabilities in the context of carbon reduction and resource security		22	1					
		Ensure an enabling social environment to maximise individual capabilities in the context of carbon reduction and resource security		6	1					
		Ensure an enabling economic environment to maximise individual capabilities in the context of carbon reduction and resource security		9	0					
		Ensure an enabling governance environment to maximise individual capabilities in the context of carbon reduction and resource security		10	2					
	Enhance biodiversity and ecosystem services	Minimise the impact of urban density on biodiversity		0	0					
ENVIRONMENT	Ensure resource efficiency	Maximise cultural services (health benefits, recreation, opportunities for outdoor learning)		4	1					
		Increase the match between city dwellers' aspirations and resource efficient living		4	0					
		Minimise energy use and waste (including heat and CO2 emissions)		34	2					
		Increase the match between wellbeing and minimising high-carbon mobilities while maximising low-carbon mobilities and immobilities of people and objects		16	0					
		Minimise potable and non-potable water use and waste (including leakage)		5	0					
		Minimise food use and waste		0	0					
		Minimise materials use and waste		5						
		Minimise other waste produced and maximise its reuse, recycling, repurposing		5	0					
		Increase awareness of, and interest in, environmental and climate change issues		9	0					
	Ensure resource security	Increase the match between city dwellers' aspirations and resource secure living		3	1					
		Maximise sustainable use of low-carbon local energy first and then maximise the security of supply of non-local energy		12	1					
		Maximise sustainable use of local water first and then maximise the security of supply of non-local water		2	0					
		Maximise sustainable use of local food first and then maximise the security of supply of non-local food		0	0					
		Maximise the sustainable use of local materials first and then maximise the security of supply of non-local materials		0	0					
		Maximise sustainable use of local people first (e.g., utilising the local workforce and leveraging local skills) and then maximise the security of supply of non-local people		1	1					
ECONOMY & FINANCE	Maximise sustainable financial investment	Maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO2 emissions)		9	10					
	Ensure economic vitality	Uncouple economic vitality from the CO2 emissions associated with economic growth		17	4					
GOVERNANCE & POLICY	Ensure appropriate governance	Uncouple governance structures and timescales from political cycles and 'colour' of governing bodies		2	4					
	Ensure appropriate policies	Uncouple policy making and policy timescales from political cycles and 'colour' of governing bodies		7	2					
				Direct	Indirect					
				199	36					
		Total impact (Direct/Indirect)			235					
	multiplier	Star rating (***)		Star rating (***)	566					

APPENDIX D STRAND ONE S1 SINGAPORE

D. 1 Initiatives & Initiations

SINGAPORE
INITIATIVES & INITIATORS

ID	Singapore Initiative		Source	Initiators	Reach
1.	Assistive Technology, Analytics and Robotics for Aging and Healthcare -	*leveraging technology that benefits everyone, especially those who need more assistance, enhance overall well-being, productivity in healthcare, improve patient care,*	https://www.smartnation.sg/initiatives/Health/assistive-technology-analytics-and-robotics-for-aging-and-healthcare	Smart Nation Singapore	**A**
2.	HealthHub Portal: A Digital Healthcare Solution	*A web portal and mobile application slated to be first one-stop online health information and services portal*	https://www.smartnation.sg/initiatives/Health/healthhub-portal--a-digital-healthcare-solution	Smart Nation Singapore	**A**
3.	National Steps Challenge: An App towards Healthy and Active Lifestyle	*encourage more Singaporeans to lead active lifestyles, started a nation-wide physical activity programme, to introduce a fun way to encourage Singaporeans to sit less and move more*	https://www.smartnation.sg/initiatives/Health/national-steps-challenge--an-app-towards-healthy-and-active-lifestyle	Smart Nation Singapore	**A**
4.	TeleHealth: Integrated and Seamless Healthcare Services at Home	*bringing care into the home, patient access to healthcare is enhanced, and productivity in our healthcare system can be improved*	https://www.smartnation.sg/initiatives/Health/telehealth--integrated-and-seamless-healthcare-services-at-home	Smart Nation Singapore	**A**
5.	Leveraging Technology to Improve our Urban Environment	*a mobile app to provide members of the public a convenient means to receive environmental news updates or report municipal issues*	https://www.smartnation.sg/initiatives/Living/leveraging-technology-to-improve-our-urban-environment	Smart Nation Singapore	**A**
6.	Smart Homes: Tech-enabled Solutions for Homes in Singapore	*smart tools simulate environmental conditions to better understand how these conditions interact with the layout and design of our town/precincts/blocks*	https://www.smartnation.sg/initiatives/Living/smart-homes--tech-enabled-solutions-for-homes-in-singapore	Smart Nation Singapore	**A**
7.	Contactless Fare Payment for Public	*new Near Field Communication (NFC) SIM, users of compatible NFC-enabled mobile phones can*	https://www.smartnation.sg/initiatives/Mobility/contactless-fare-	Smart Nation Singapore	**A**

	Transport in Singapore	*simply tap in and out of the MRT, LRT and public buses using their phones. NFC-enabled payments are also accepted on taxis*	payment-for-public-transport-in-singapore		
8.	Mobility-on-Demand	*real-time Demand-driven Transport through Apps*	https://www.smartnation.sg/initiatives/Mobility/mobility-on-demand--real-time-demand-driven-transport-through-apps	Smart Nation Singapore	**A**
9.	Open Data and Analytics for Urban Transportation	*new technologies to address transport challenges, to make existing land transport system more efficient through the collection and analysis of data to help in resource planning so as to meet the demands of our citizens with limited buses*	https://www.smartnation.sg/initiatives/Mobility/open-data-and-analytics-for-urban-transportation	Smart Nation Singapore	**A**
10	Self-Driving Vehicles (SDVs): Future of Mobility in Singapore	*launched trials for autonomous mobility-on-demand services, which are envisaged to comprise a fleet of shared self-driving shuttles or pods*	https://www.smartnation.sg/initiatives/Mobility/self-driving-vehicles-sdvs--future-of-mobility-in-singapore	Smart Nation Singapore	**A**
11	Spearheading Research in Standards for Self-Driving Vehicles (SDVs)	*CETRAN will spearhead the development of testing requirements for SDVs, to provide industry players with a simulated road environment for the testing SDVs prior to their deployment on public roads*	https://www.smartnation.sg/initiatives/Mobility/spearheading-research-in-standards-for-self-driving-vehicles-sdvs	Smart Nation Singapore	**A**
12	Digital Government: Public Services Made More Seamless with Technology	*public service will transform into a Digital Government that delivers services with citizens at the heart of it*	https://www.smartnation.sg/initiatives/Services/digital-government--public-services-made-more-seamless-with-technology	Smart Nation Singapore	**A**
13	Regulatory Sandbox for Innovative Fintech Experimentation	*supports innovation in the financial services, and where financial institutions can experiment with the application of new technologies in a safe environment*	https://www.smartnation.sg/initiatives/Services/regulatory-sandbox-for-innovative-fintech-experimentation	Smart Nation Singapore	**A**
14	Towards a Smart Cashless Society with Contactless Payment	*contactless stored-value cards for fare payment on public transport*	https://www.smartnation.sg/initiatives/Services/towards-a-smart-cashless-society-with-contactless-payment	Smart Nation Singapore	**A**
15	Business Grants Portal	*a one-stop portal for businesses to apply for grants according to their needs without having to approach multiple agencies*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/business-	GOVTECH Singapore	**A**

			grants-portal		
16	AD-Box Design Challenge Call for proposal	*an array of intelligent sensors monitoring vehicle, human traffic and environmental changes amongst others*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/collaborations/ag-box-design-challenge-call-for-proposal	GOVTECH Singapore	**C**
17	Technology Associate Programme	*an exclusive leadership-trainee programme carefully designed to develop your technical knowledge and professional skills*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/tap	GOVTECH Singapore	**U**
18	Tech Kaki Community	*a community set up by GovTech for citizen participation on new tech products before they go live and be part of the development team to make them better*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/tech-kaki-community	GOVTECH Singapore	**A**
19	Whole of Government 'Ask Jamie' Virtual Assistant	*a virtual assistant (VA) that can be implemented on agency websites and trained to be able to answer queries within specific domains*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/virtual-assistant	GOVTECH Singapore	**A**
20	Singapore Personal Access (SignPass)	*an authentication system for citizens to access to all Government e-services*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/singpass	GOVTECH Singapore	**A**
21	Smart Nation Fellowship Programme	*an innovative engineering and technology talent within the government able to leverage cutting edge technology trends and build meaningful digital and data solutions that can help improve the lives of citizens*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/smart-nation-fellowship-programme	GOVTECH Singapore	**A**
22	Citizen Connect	*aims to provide an easy and convenient means for the public to transact with the Government, from amongst 1700 Government services, through the Internet*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/citizenconnect	GOVTECH Singapore	**A**
23	Agile Development	*a software development methodology characterised by iterative, incremental development demonstrating significant productivity benefits such as faster time-to-markets for development and cost-savings for customers*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/agile-development	GOVTECH Singapore	**U**

24	National Trade Platform	*a one-stop next-generation trade information management platform to support companies in the trade and logistics industry, as well as adjacent sectors such as trade finance*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/national-trade-platform	GOVTECH Singapore	**A**
25	CorpPass	*a corporate digital identity for businesses and other entities (such as non-profit organisations and associations) to transact with Government agencies online*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/corppass	GOVTECH Singapore	**A**
26	GovTech Cloudstore	*it provides a channel for service providers to showcase their offerings to agencies*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/govtech-cloudstore	GOVTECH Singapore	**C**
27	Smart Nation Platform (SNP) Industry Roundtable (IR)	*drives a wide array of smart initiatives to improve the lives of citizens through better public service delivery and greater day-to-day convenience*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/collaborations/smart-nation-platform-industry-roundtable	GOVTECH Singapore	**C**
28	TRANS Grant	*funds translational R&D and technology or process innovations in areas that are aligned to the emerging and focused tech areas (Strategic National Projects (SNPs) and Centres of Excellence (CentEx))*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/trans-grant	GOVTECH Singapore	**A**
29	Smart Nation Sensor Platform	*people and businesses empowered through increased access to data, participatory through the contribution of innovative ideas and solutions, more anticipatory government that utilises technology to better serve citizens' needs*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/smart-nation-sensor-platform	GOVTECH Singapore	**A**
30	TradeXchange	*provides a neutral and secure platform that enables seamless exchange of information within the supply chain and logistics community*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/tradexchange	GOVTECH Singapore	**A**
31	Unique Entity Number	*a single identity number for unique interaction with the government*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/unique-entity-number	GOVTECH Singapore	**A**

32	SME Portal	*the first stop for Singapore SME owners and aspiring entrepreneurs looking for information, tools and services that can help them build sustainable and competitive businesses*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/sme-portal	GOVTECH Singapore	**A**
33	Social Service Sector ICT Master Plan	*dynamic changes in the review and deployment of programmes to better serve clients' needs*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/social-service-sector-ict-master-plan	GOVTECH Singapore	**A**
34	Data.gov.sg	*beyond being a data repository, aims to make government data relevant and understandable to the public, through the active use of data visualisations and data-driven articles*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/data-gov-sg	GOVTECH Singapore	**A**
35	Beeline	*an open, cloud-based smart mobility platform developed to provide data-driven shuttle bus services for commuters*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/beeline	GOVTECH Singapore	**A**
36	eCitizen ideas!	*crowdsourcing activities in the form of challenges, such as contests for idea generation, application development, hackathons, to solve problems and issues that Singaporeans may be facing*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/ecitizen-ideas	GOVTECH Singapore	**A**
37	MyInfo	*one-stop data platform that saves time by automatically filling out government e-forms*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/myinfo	GOVTECH Singapore	**A**
38	InnoLeap	*brings together public sector agencies with challenging problem statements and RIs, IHLs, and commercial entities with innovative solutions*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/innoleap	GOVTECH Singapore	**A**
39	Government IT Security Incident Response (GITSIR) Team	*a primary point of contact for all security incidents in the Government and serves as a central interface for coordinating with external parties*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/gitsir	GOVTECH Singapore	**U**
40	National Authentication Framework	*seeks to realise the vision of the iN2015 masterplan for a secure and trusted enabling infocomm infrastructure that can facilitate the delivery of online services by the public and private sectors*	https://www.tech.gov.sg/programmes-partnerships/programmes-partnerships/initiatives/national-authentication-framework	GOVTECH Singapore	**U**
41	Outward Bound Singapore (OBS)	*outdoor educational institution strengthening youth resilience and ruggedness while also developing*	https://obs.nyc.gov.sg/	National Youth Council NYC	**A**

	Programmes	*youth leaders and mentors*			
42	Young Change Makers (YCM)	*supports youth initiated projects that benefit the Singapore community and society. It also helps to empower youth as decision makers to evaluate projects and mentor project applicants*	https://www.nyc.gov.sg/en/initiatives/grants/young-changemakers/	National Youth Council NYC	**A**
43	OBS Leadership and Service Award	*celebrates and recognizes youths with outstanding contributions in leadership and service in our community. LSA winners are offered a scholarship to participate in the internationally-renowned 21-day OBS Classic Challenge Course*	https://www.nyc.gov.sg/en/initiatives/recognition/obs-leadership-and-service-award/	National Youth Council NYC	**A**
44	Singapore Youth Award	*highest accolade for youth, the Singapore Youth Award (SYA) honours exceptional young people who enrich the hearts and souls of the community and bring distinction to the nation*	https://www.nyc.gov.sg/en/initiatives/recognition/singapore-youth-award/	National Youth Council NYC	**A**
45	Singapore-ASEAN Youth Fund (SAYF)	*network with one another, share best practices and partner one another in joint youth projects to foster greater community building efforts*	https://www.nyc.gov.sg/en/initiatives/grants/singapore-asean-youth-fund/	National Youth Council NYC	**A**
46	Youth Corps Singapore	*meaningful and enriching volunteering experiences*	https://www.nyc.gov.sg/en/initiatives/programmes/youth-corps-singapore/	National Youth Council NYC	**A**
47	SHINE Festival 2017	*anchored on the theme "Own Your Dreams", where youths are pushed and groomed to actively pursue their dreams and aspirations*	https://www.nyc.gov.sg/en/initiatives/programmes/shine/	National Youth Council NYC	**A**
48	Youth conversations	*as a young person living in Singapore, you have views on national issues that have an impact on you and your families*	https://www.nyc.gov.sg/en/initiatives/programmes/youth-conversations/	National Youth Council NYC	**A**
49	Youth Expedition Project (YEP)	*scheme supports youth from educational institutions and registered organisations to embark on Service-Learning projects that involve communities in ASEAN, China, India and Singapore*	https://www.nyc.gov.sg/en/initiatives/grants/youth-expedition-project/	National Youth Council NYC	**U**
50	National Youth Survey	*a time-series study into the major concerns and issues of schooling and working youths in Singapore*	https://www.nyc.gov.sg/en/initiatives/resources/national-youth-survey/	National Youth Council NYC	**C**

51	Y+	*NYC's quarterly e-newsletter on the youth scene. Y+ provides you with snippets of youth trends and issues from diverse sources around the world to help you stay in touch with the constantly evolving youth scene*	https://www.nyc.gov.sg/en/initiatives/resources/y/	National Youth Council NYC	**C**
52	Youth Statistics in Brief	*paints the big picture of the state of youth (aged 15-34)areas covered are: Population, Education, Employment, Marriage and Divorce, Health, Sports and Participation, Aspirations as well as Civic Engagement*	https://www.nyc.gov.sg/en/initiatives/resources/youth-statistics-in-brief/	National Youth Council NYC	**C**

D.2 Benefits & Impacts

SINGAPORE **BENEFITS & IMPACTS**			
ID	**Singapore Initiative**	**Aims and Intended Benefits**	**Impacts (Direct and Indirect Benefit)**
1.	Assistive Technology, Analytics and Robotics for Aging and Healthcare -	*Aims to leverage technology that benefits everyone, especially those who need more assistance; to strengthening communities*	**Direct** –ensure the elderly do their exercise routines correctly; provide physical and cognitive therapy to seniors; enhance the learning and communication experiences of the visually impaired **Indirect** –Enhance overall well-being; Enhance productivity in healthcare; Improve patient care
2.	HealthHub Portal: A Digital Healthcare Solution	*Aims to be Singapore's first one-stop online health information and services portal*	**Direct** –Access: personal hospital records; immunisation records; extensive directory of healthcare and lifestyle facilities and services; earn and accumulate Healthpoints that can be converted into rewards **Indirect** –provide continuity of care for patients
3.	National Steps Challenge: An App towards Healthy and Active Lifestyle	*Aims to encourage more Singaporeans to lead active lifestyles -*	**Direct** –nation-wide physical activity programme, called the "National Steps Challenge™", to introduce a fun way to encourage Singaporeans to sit less and move more **Indirect** –use of wearable technology and simple data analytics, users receive feedback on their daily progress and also earned rewards upon achieving certain milestones

4.	TeleHealth: Integrated and Seamless Healthcare Services at Home	*Aims to bringing care into the home, patient access to healthcare is enhanced, and productivity in our healthcare system can be improved*	**Direct** –offering integrated and seamless care to effectively meet healthcare needs ; Optimise resources to overcome manpower constraints in the healthcare sector; Deliver quality healthcare to an ageing population; Enabling our elderly to age-in-place;Reduced need for patients and their caregivers to travel and wait for appointments in hospitals **Indirect** –elderly monitoring system can help provide peace of mind to caregivers while they are away from home
5.	Leveraging Technology to Improve our Urban Environment	*Aims to provide members of the public a convenient means to receive environmental news updates or report municipal issues.*	**Direct** –Municipal services are delivered more effectively; Interaction between residents and Government agencies on issues relating to them and their neighbourhood is enhanced, and in turn helps improve the living environment for Singaporeans **Indirect** –help in the up keeping and improvement of common living environment -
6.	Smart Homes: Tech-enabled Solutions for Homes in Singapore	*Aims to evaluate how smart home applications can help residents achieve greater convenience, utilities savings, as well as ensure peace of mind for families with elderly family members*	**Direct** –Smart tools can simulate environmental conditions to better understand how these conditions interact with the layout and design of our town/precincts/blocks; smart home applications can help residents achieve greater convenience, utilities savings, as well as ensure peace of mind for families with elderly family members **Indirect** –smart technologies enhance our living environment
7.	Contactless Fare Payment for Public Transport in Singapore	*Aims to leverage new technologies to make fare payments on public transport more convenient for commuters*	**Direct** – innovative payment systems **Indirect** –
8.	Mobility-on-Demand	*Aims to leverage real time transport*	**Direct** –real time and autonomous transport **Indirect** –tech companies to build their own “retail” applications
9.	Open Data and Analytics for Urban Transportation	*Aims to help in resource planning so as to meet the demands of our citizens with limited buses*	**Direct** –identifying commuter hotspots to manage bus fleets; real-time location data of buses helps facilitate transport planning to better meet commuters' demands; anticipate and address the needs of different types of commuters through improved policy planning **Indirect** –creating people-centric transport solutions

10	Self-Driving Vehicles (SDVs): Future of Mobility in Singapore	*Aims to bring in new forms of shared mobility, also to address the constraints we face in land and manpower*	**Direct** –develop solutions for autonomous truck platooning to transport containers from one port terminal to another, as well as issued a Request for Information for the development of self-driving utility vehicles for waste collection and road sweeping **Indirect** –develop and test mobility concepts and self-driving buses, and SDVs for shared, on-demand, point-to-point mobility; pave the way for SDVs to become, in time, an integral part of the Singapore transport system
11	Spearheading Research in Standards for Self-Driving Vehicles (SDVs)	*Aims to spearhead the development of testing requirements for SDVs*	**Direct** –enable Singapore to move closer to its goal of deploying self-driving vehicles (SDVs) for shared transport **Indirect** –place Singapore at the global forefront to develop standards to safely integrate SDVs into transport system
12	Digital Government: Public Services Made More Seamless with Technology	*Aims (agencies) re-designing online services and underlying processes*	**Direct** –processes to make them simpler to use and easier to access, including providing more services on mobile devices **Indirect** –delivers services with citizens at the heart of it
13	Regulatory Sandbox for Innovative Fintech Experimentation	*Aims to create a Smart Financial Centre where technology is used pervasively in the financial industry*	**Direct** –FinTech environment that supports innovation in the financial services, and where financial institutions such as banks, can experiment with the application of new technologies in a safe environment **Indirect** –increase efficiency, create economic opportunities, and allow for better management of risks -
14	Towards a Smart Cashless Society with Contactless Payment	*Aims to a develop a Smart Cashless Society*	**Direct** –lower transaction costs for all businesses and for citizens who are purchasing goods and services; lowest possible transaction cost **Indirect** –enhance competitiveness and participation in economy
15	Business Grants Portal	*Aims to create a portal for businesses to apply for grants according to their needs without having to approach multiple agencies*	**Direct** –apply for grants easily through a simple application process; routing of applications to the relevant agency; simplifying the process of providing company related information **Indirect** –simple business application process
16	AD-Box Design Challenge Call for proposal	*Aims to empower sensors by making both connectivity and power available at outdoor locations*	**Direct** –physical design; functionality; effective space utilisation **Indirect** –sensors deployed nationwide
17	Technology Associate Programme	*Aimed to develop technical knowledge and professional skills*	**Direct** –specialist training; technical roles within GovTech that will accelerate your career development

			Indirect –innovative use of technology can enhance the lives of fellow Singaporeans
18	Tech Kaki Community	*Aims to transform the delivery of Government digital services*	**Direct** –first dibs on new tech products before they go live and be part of the development team to make them better **Indirect** –community set up by GovTech for citizen participation
19	Whole of Government 'Ask Jamie' Virtual Assistant	*Aims to (implemented on agency websites) to be able to answer queries within specific domains*	**Direct** –eliminates the need for the public to know which agency websites to go to for specific queries **Indirect** –leveraging on an agency backend database, the Gov iFAQ system and the Wolfram Alpha general knowledge database
20	Singapore Personal Access (SignPass)	*Aims to citizens' access to all Government e-services*	**Direct** –improved user interface, mobile-friendly features and stronger security capabilities **Indirect** –provide users with a high level of confidence; enable end-to-end encryption of user IDs and passwords, promising a high level of availability and resiliency
21	Smart Nation Fellowship Programme	*Aims to harness technology and data to improve the lives of citizens*	**Direct** –develop a strong nucleus of innovative engineering and technology talent within the government who are able to leverage cutting edge technology trends and build meaningful digital and data solutions **Indirect** –help improve the lives of citizens
22	Citizen Connect	*Aims to an easy and convenient means for citizens to transact with the Government online*	**Direct** –offer free access to Internet-enabled computing devices **Indirect** –teach users to perform online transactions
23	Agile Development	*Aims to iterative and incremental development, and demonstrating significant productivity benefits*	**Direct** –faster time-to-markets for development and cost-savings for customers **Indirect** –help companies assess their level of maturity in agile methodologies
24	National Trade Platform	*Aims to improve Singapore's competitiveness as the world's leading trade, supply chain and trade financing hub*	**Direct** –support firms, particularly in the logistics and trade finance sectors, to improve supply chain visibility and efficiency **Indirect** –innovation platform, which businesses and service providers can tap on to develop new applications to support evolving business needs
25	CorpPass	*Aims to roll out a single corporate digital identity*	**Direct** –increase convenience for users who transact with multiple government agencies, as they no longer need to handle multiple login IDs; services and transactions to be provided online conveniently and securely **Indirect** –businesses to have greater control; grant and manage

			employees' access to Government digital services
26	GovTech Cloudstore	*Aims to collect applications to GovTech for qualification via a Call for Participation process*	**Direct** –benefit the industry as it provides a channel for service providers to showcase their offerings to agencies; procurement of these services will be simplified **Indirect** –faster turnaround time and improve public service delivery
27	Smart Nation Platform (SNP) Industry Roundtable (IR)	*Aims to build the next generation enabling infrastructure for the Singapore Government*	**Direct** –further develop capabilities in pervasive connectivity and new infrastructure to enable government agencies to better leverage on technology **Indirect** –improve the lives of citizens through better public service delivery and greater day-to-day convenience
28	TRANS Grant	*Aims to solve public sector challenges, demonstrates feasibility of new ideas and encourages agencies to experiment and deploy innovative solutions*	**Direct** –help to offset costs arising from the projects undertaken under each approved proposal **Indirect** –co-create solutions with the TRANS Labs and relevant government agencies for deployment and commercialisation of the solutions
29	Smart Nation Sensor Platform	*Aims to improve the lives of citizens, creating more opportunities, and building stronger communities*	**Direct** –co-create a Smart Nation together; good governance, infrastructure, and boosting our capabilities **Indirect** –utilise technology to better serve citizens' needs
30	TradeXchange	*Aims to enable seamless exchange of information within the supply chain and logistics community*	**Direct** –businesses can have a more efficient mechanism to exchange essential information across the supply chain; businesses will enjoy greater operational efficiencies, clearer supply chain visibility; faster shipment turnaround and productivity due to more timely exchanges of information and documents across their partners in the value chain **Indirect** –innovate and streamline the supply chain through the use of TradeXchange
31	Unique Entity Number	*Aims to issue an employer number issued by the Central Provident Fund Board to all employers*	**Direct** –conversion software that maps the UEN to existing identifiers were provided to public, private and social sector agencies **Indirect** –a single identity for businesses, companies and societies
32	SME Portal	*Aims to help build sustainable and competitive businesses*	**Direct** –centralised information on government assistance schemes, industry insights and exclusive offers on business solutions; commercial resources; account to receive personalised

			information and services based on their interests and business **Indirect** –like-minded individuals across industries to achieve common business goals
33	Social Service Sector ICT Master Plan	*Aims to inspire responsible individuals to live a life of dignity and purpose in an inclusive society, where they are empowered and are able to achieve self-sustenance*	**Direct** –address challenges in greater demand for skilled manpower, the pressing need for more prevalent data in service planning, and greater demand from clients on better and more effective service delivery **Indirect** –to better serve clients' needs
34	Data.gov.sg	*Aims to offer publicly available datasets from 70 public agencies*	**Direct** –developers and analysts can now access government open data APIs from different agencies via the portal instead of signing up with individual agencies **Indirect** –apps through government's open data
35	Beeline	*Aims to provide data-driven shuttle bus services for commuters*	**Direct** –commuters are empowered to "crowd- start" and activate more direct, private express bus routes that cater to their travel needs **Indirect** –empowers the commuters, by allowing them to participate in the route designing process
36	eCitizen ideas!	*Aims to participate in challenges by all Government agencies*	**Direct** –contests for idea generation, application development, hackathons **Indirect** –solve problems and issues that Singaporeans may be facing
37	MyInfo	*Aims to save time by automatically filling out government e-forms*	**Direct** –able to use the MyInfo feature on digital services that pertain to every Singaporean **Indirect** –making government transactions easier than ever
38	InnoLeap	*Aims to a deeper understanding of hurdles, solutions and cultivate opportunities for collaboration*	**Direct** –innovative ideas and solutions developed by Research Institutes (RIs), Institutes of Higher Learning (IHLs), and commercial entities **Indirect** –encourage the spirit of innovation within the government sector
39	Government IT Security Incident Response (GITSIR) Team	*Aims to support the IT Security Incident Framework for the Government*	**Direct** –Technical assistance to assist sites to investigate, resolve and recover from security incidents; security alerts, advisories, patches and news to SIRM and SIRO; enrichment programmes to enhance the SIRM and SIRO ability to perform their functions **Indirect** –a central interface for coordinating with external parties such as other government agencies, external organisations,

			Internet Service Providers and law enforcement
40	National Authentication Framework	*Aims to realise the vision of the iN2015 masterplan for a secure and trusted enabling infocomm infrastructure that can facilitate the delivery of online services by the public and private sectors*	**Direct** –safeguard against unauthorised access to sensitive information available online, such as bank account details, securities trading account details or electronic health records **Indirect** –strong authentication infrastructure that can provide consumers greater assurance when performing online transactions
41	Outward Bound Singapore (OBS) Programmes	*Aims to strengthen youth resilience and ruggedness; develop youth leaders and mentors; through the growth of our Alumni and promoting excellence in outdoor education*	**Direct** –create the Outward Bound Singapore (OBS) experience capturing your heart, mind & imagination **Indirect** –mentally & physically rugged youths to be active citizens Inspired to serve the community
42	Young Change Makers (YCM)	*Aims to empower youth as decision makers to evaluate projects and mentor project applicants*	**Direct** –empower youths as decision makers to evaluate projects and mentor project applicants **Indirect** –benefit the Singapore community and society
43	OBS Leadership and Service Award	*Aims to recognise youth's capabilities, develops their inner potential, and inspires them to be community-minded*	**Direct** –offered a scholarship to participate in the internationally-renowned 21-day OBS Classic Challenge Course **Indirect** –celebrates and recognizes youths with outstanding contributions in leadership and service in our community
44	Singapore Youth Award	*Aim to boldly create possibilities for the good of the community*	**Direct** –individuals as well as teams who inspire youth to boldly create possibilities for the good of the community **Indirect** –enrich the hearts and souls of the community and bring distinction to the nation
45	Singapore-ASEAN Youth Fund (SAYF)	*Aims to promote greater interaction among ASEAN youth*	**Direct** –youth interaction and greater mutual understanding with other YSOs **Indirect** –foster greater community building efforts
46	Youth Corps Singapore	*Aims to co-create sustainable and meaningful projects for the community*	**Direct** –quality training and mentoring, and also get opportunities to network with like-minded youths and learn from people in the public and private sectors **Indirect** –meaningful and enriching volunteering experiences; match your passion, interests or causes with community needs
47	SHINE Festival 2017	*Aims to call out for aspiring youths to take part in our SHINE x *SCAPE Talent Development*	**Direct** –pursue dreams in music, dance, media, sports or esports **Indirect** –recognising the many different interests
48	Youth conversations	*Aims to a platform to say what matters, connect with peers, and come up with ideas for change*	**Direct** –enter your own statements; check out what others have voted **Indirect** –

49	Youth Expedition Project (YEP)	*Aims to study into the major concerns and issues of schooling and working youths*	**Direct** –confidence and potential as a youth volunteer and embark on community Service-Learning projects both locally and off shores with Youth Expedition Project (YEP) **Indirect** –confident and resilient youths who are active citizens with the desire to make a difference both at home and overseas
50	National Youth Survey	*Aims to major concerns and issues of schooling and working youths in Singapore*	**Direct** – empower youths journey; boost resilience; enlarge their sense of purpose; deepen social ties **Indirect** –state of youths
51	Y+	*Aims to a quarterly e-newsletter on the youth scene*	**Direct** –snippets of youth trends and issues from diverse sources around the world **Indirect** –stay in touch with the constantly evolving youth scene
52	Youth Statistics in Brief	*Aims to paint the big picture of the state of youth (aged 15-34)*	**Direct** –education indicators; labour force indicators; marital status; population; at risk behaviours; sports participation technology use **Indirect** –statistics

D.3 Singapore Overview of Initiatives according to CityLIFE Actions

LENS	GOAL	ACTION	SINGAPORE INITIATIVES	1 Assistive Technology, Analytics and Robotics	* * *	2 HealthHub Portal	* *	3 National Steps Challenge	* *	4 Telehealth	* * *	5 Leveraging Technology (Urban Environment)	* *	6 Smart Homes: Tech-enabled Solutions	* *	7 Contactless Fare Payment for Public Transport	* * *
				Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
SOCIETY	Enhance community and individual wellbeing	Promote healthy living and healthy long lives			X	X			X	X							X
		Increase the match between city dweller aspirations and wellbeing		X		X		X		X		X					
		Minimise ill-being			X		X	X			X						X
		Maximise cultural benefit		X		X			X		X						
	Ensure equity (Fairness)	Ensure an enabling physical environment to maximise individual capabilities in the context of carbon reduction and resource security													X		
		Ensure an enabling social environment to maximise individual capabilities in the context of carbon reduction and resource security		X		X		X			X			X			
		Ensure an enabling economic environment to maximise individual capabilities in the context of carbon reduction and resource security															
		Ensure an enabling governance environment to maximise individual capabilities in the context of carbon reduction and resource security											X				
	Enhance biodiversity and ecosystem services	Minimise the impact of urban density on biodiversity															
ENVIRONMENT	Ensure resource efficiency	Maximise cultural services (health benefits, recreation, opportunities for outdoor learning)				X		X		X							
		Increase the match between city dwellers' aspirations and resource efficient living															
		Minimise energy use and waste (including heat and CO2 emissions)															
		Increase the match between wellbeing and minimising high-carbon mobilities while maximising low-carbon mobilities and immobilities of people and objects															
		Minimise potable and non-potable water use and waste (including leakage)															
		Minimise food use and waste															
		Minimise materials use and waste															
		Minimise other waste produced and maximise its reuse, recycling, repurposing															
		Increase awareness of, and interest in, environmental and climate change issues															
	Ensure resource security	Increase the match between city dwellers' aspirations and resource secure living															
		Maximise sustainable use of low-carbon local energy first and then maximise the security of supply of non-local energy															
		Maximise sustainable use of local water first and then maximise the security of supply of non-local water															
		Maximise sustainable use of local food first and then maximise the security of supply of non-local food															
		Maximise the sustainable use of local materials first and then maximise the security of supply of non-local materials															
		Maximise sustainable use of local people first (e.g., utilising the local workforce and leveraging local skills) and then maximise the security of supply of non-local people															
ECONOMY & FINANCE	Maximise sustainable financial investment	Maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO2 emissions)															
	Ensure economic vitality	Uncouple economic vitality from the CO2 emissions associated with economic growth															
GOVERNANCE & POLICY	Ensure appropriate governance	Uncouple governance structures and timescales from political cycles and 'colour' of governing bodies										X					
	Ensure appropriate policies	Uncouple policy making and policy timescales from political cycles and 'colour' of governing bodies										X					
				Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
				3	2	5	1	4	2	3	3	3	1	1	1	0	2
		Total impact (Direct/Indirect)			5		6		6		6		4		2		5
	multiplier	Star rating (***)			15		18		18		18		8		4		15

8	* *	9	* * *	10	*	11	*	12	* * *	13	* *	14	* * *	15	* *	16	* *	17	*	18	* * *	19	* * *
Mobility-on-Demand: Real-time Demand-driven Transport		Open Data and Analytics for Urban Transportation		Self-Driving Vehicles (SDVs): Future of Mobility		Standards for Self-Driving Vehicles (SDVs)		Digital Government		Regulatory Sandbox		Towards a Smart Cashless Society		Business Grants Portal		AD-Box Design Challenge Call for proposal		Technology Associate Programme		Tech Kaki Community		Whole of Government 'Ask Jamie'	
Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
																X			X		X		X
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Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
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	1		1		2		2		4		1		1		2		1		4		3		3
	2		3		2		2		12		2		3		4		2		4		9		9

20		* * *		21		* *		22		* * *		23		* *		24		* *		25		* *		26		*		27		* * *		28		* *		29		* * *		30		* *		31		* *		32		* *
Singapore Personal Access (SingPass)				Smart Nation Fellowship				Citizen Connect				Agile Development				National Trade Platform				CorpPass				GovTech Onedrive				Smart Nation Platform (SNP)				TRANS Grant				Smart Nation Sensor Platform				TradeXchange				Unique Entity Number				SME Portal		
Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect
		X				X																								X						X						X				X	
										X																																	X				X
										X																																				

33		* * *		34		* * *		35		* * *		36		* *		37		* * *		38		* * *		39		* * *		40		* * *		41		*		42		*		43		*		44		*		45		*
Social Service Sector ICT				Data.gov.sg				Beeline				eCitizen ideas!				MyInfo				InnoLeap				Government IT Security Incident Response				National Authentication Framework				Outward Bound Singapore (OBS) Programmes				Young Change Makers (YCM)				OBS Leadership and Service Award				Singapore Youth Award				Singapore-ASEAN Youth Fund (SAYF)		
Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect		Direct		Indirect
																																		X													
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		X																X														X				X				X				X				X	
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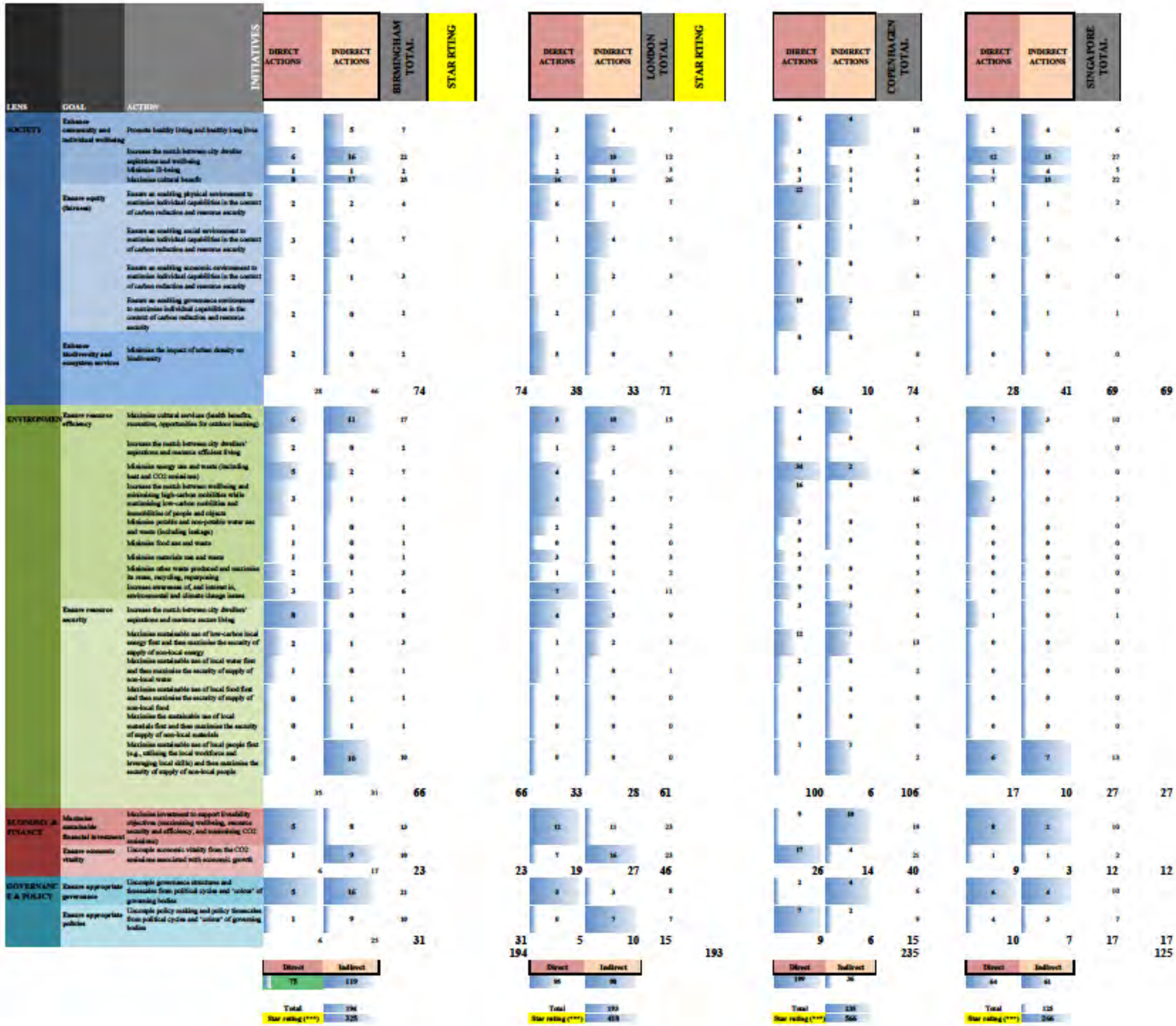
										X																																					

46	*	47	*	48	*	49	*	50	*	51	*	52	*
Youth Corps Singapore		SHINE Festival		Youth conversations		Youth Expedition Project (YEP)		National Youth Survey		Y*		Youth Statistics in Brief	
Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
X			X				X		X	X			
	X			X			X	X				X	
X						X							
		X											
X		X		X			X		X		X	X	
Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
3	1	2	1	2	0	1	3	1	2	1	1	2	0
	4		3		2		4		3		2		0
	4		3		1		4		3		2		0

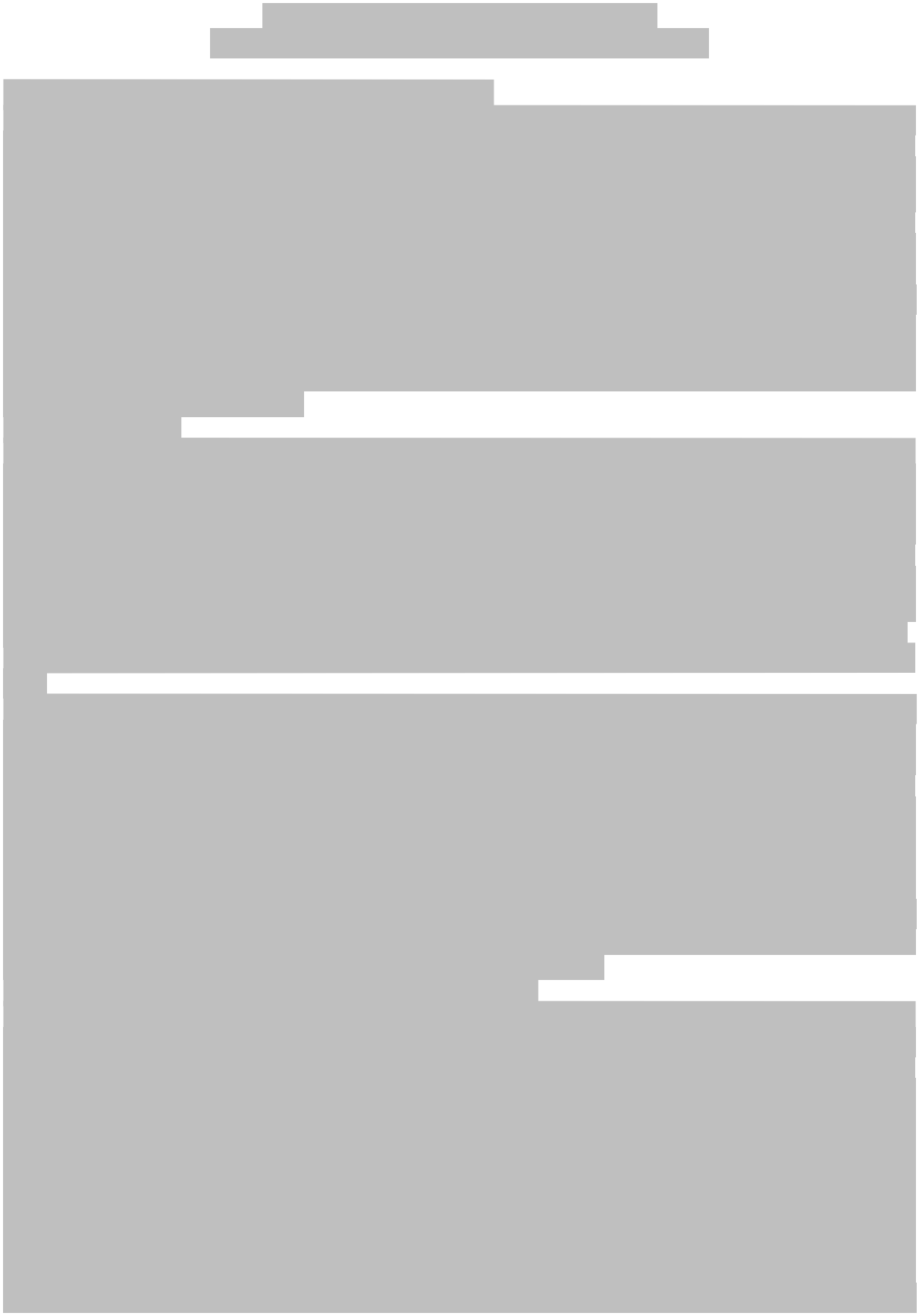
					Three ***	Two **	One *	Multiplier
		SINGAPORE INITIATIVES	DIRECT ACTIONS	INDIRECT ACTIONS	Impacts the whole population	Impact to a wider population group	Benefit(s) to only one group	
LENS	GOAL	ACTION	TOTAL	TOTAL	19	17	16	266
SOCIETY	Enhance community and individual wellbeing	Promote healthy living and healthy long lives	2	4				
		Increase the match between city dweller aspirations and wellbeing	12	15				
		Minimise ill-being	1	4				
		Maximise cultural benefit	7	15				
	Ensure equity (fairness)	Ensure an enabling physical environment to maximise individual capabilities in the context of carbon reduction and resource security	1	1				
		Ensure an enabling social environment to maximise individual capabilities in the context of carbon reduction and resource security	5	1				
		Ensure an enabling economic environment to maximise individual capabilities in the context of carbon reduction and resource security	0	0				
		Ensure an enabling governance environment to maximise individual capabilities in the context of carbon reduction and resource security	0	1				
	Enhance biodiversity and ecosystem services	Minimise the impact of urban density on biodiversity	0	0				
ENVIRONMENT	Ensure resource efficiency	Maximise cultural services (health benefits, recreation, opportunities for outdoor learning)	7	3				
		Increase the match between city dwellers' aspirations and resource efficient living	0	0				
		Minimise energy use and waste (including heat and CO2 emissions)	0	0				
		Increase the match between wellbeing and minimising high-carbon mobilities while maximising low-carbon mobilities and immobilities of people and objects	3	0				
		Minimise potable and non-potable water use and waste (including leakage)	0	0				
		Minimise food use and waste	0	0				
		Minimise materials use and waste	0	0				
		Minimise other waste produced and maximise its reuse, recycling, repurposing	0	0				
		Increase awareness of, and interest in, environmental and climate change issues	0	0				
	Ensure resource security	Increase the match between city dwellers' aspirations and resource secure living	1	0				
		Maximise sustainable use of low-carbon local energy first and then maximise the security of supply of non-local energy	0	0				
		Maximise sustainable use of local water first and then maximise the security of supply of non-local water	0	0				
		Maximise sustainable use of local food first and then maximise the security of supply of non-local food	0	0				
		Maximise the sustainable use of local materials first and then maximise the security of supply of non-local materials	0	0				
		Maximise sustainable use of local people first (e.g., utilising the local workforce and leveraging local skills) and then maximise the security of supply of non-local people	6	7				
ECONOMY & FINANCE	Maximise sustainable financial investment	Maximise investment to support liveability objectives (maximising wellbeing, resource security and efficiency, and minimising CO2 emissions)	8	2				
	Ensure economic vitality	Uncouple economic vitality from the CO2 emissions associated with economic growth	1	1				
GOVERNANCE & POLICY	Ensure appropriate governance	Uncouple governance structures and timescales from political cycles and 'colour' of governing bodies	6	4				
	Ensure appropriate policies	Uncouple policy making and policy timescales from political cycles and 'colour' of governing bodies	4	3				
			64	61				
		Total impact (Direcrt/Indirect)		125				
	multiplier	Star rating (***)	Star rating (***)	215				

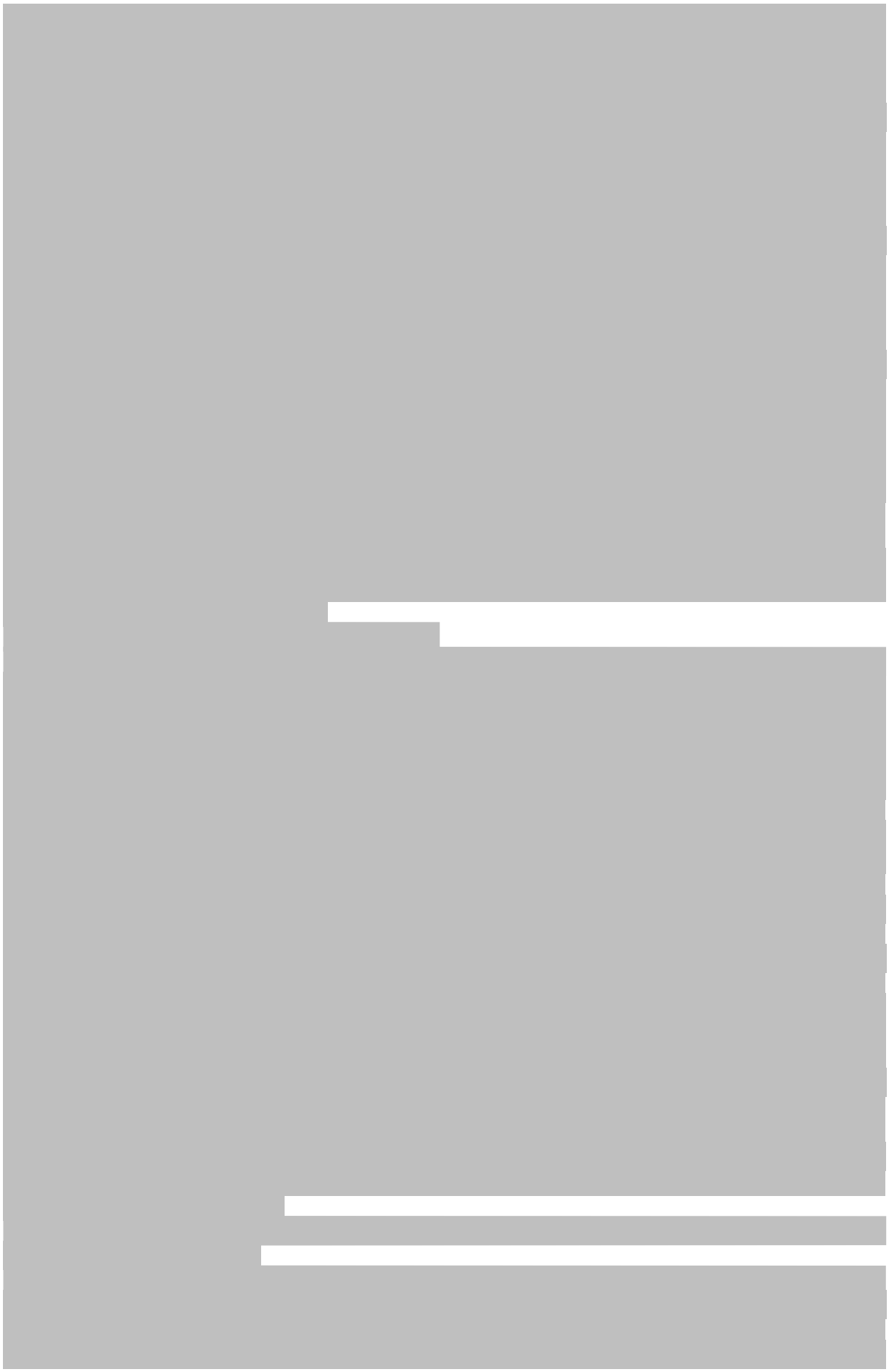
APPENDIX E TOTAL COMPARISON – FOUR CASE STUDIES


INITIATIVES
DIRECT ACTIONS
INDIRECT ACTIONS
BIRMINGHAM TOTAL
STAR RTING
LONDON TOTAL
COPENHAGEN TOTAL
SINGAPORE TOTAL
LENS
GOAL
ACTIO
SOCIETY
ENVIRONMEN
ECONOMY & FINANCE
GOVERNANC E & POLICY
Direct
Indirect
Total
Star rating (***)

APPENDIX F STRAND TWO S2 BIRMINGHAM

Participant 1





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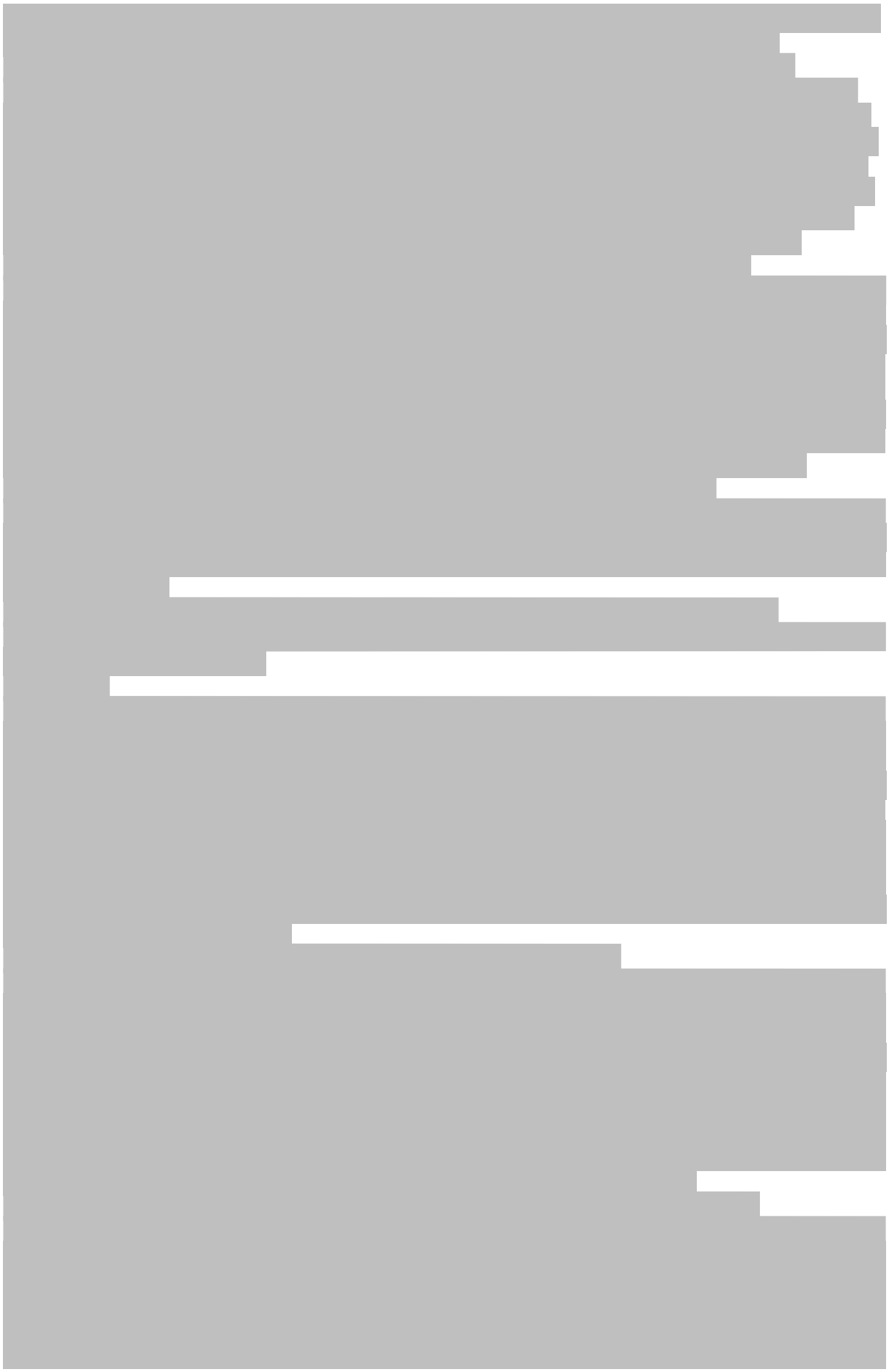
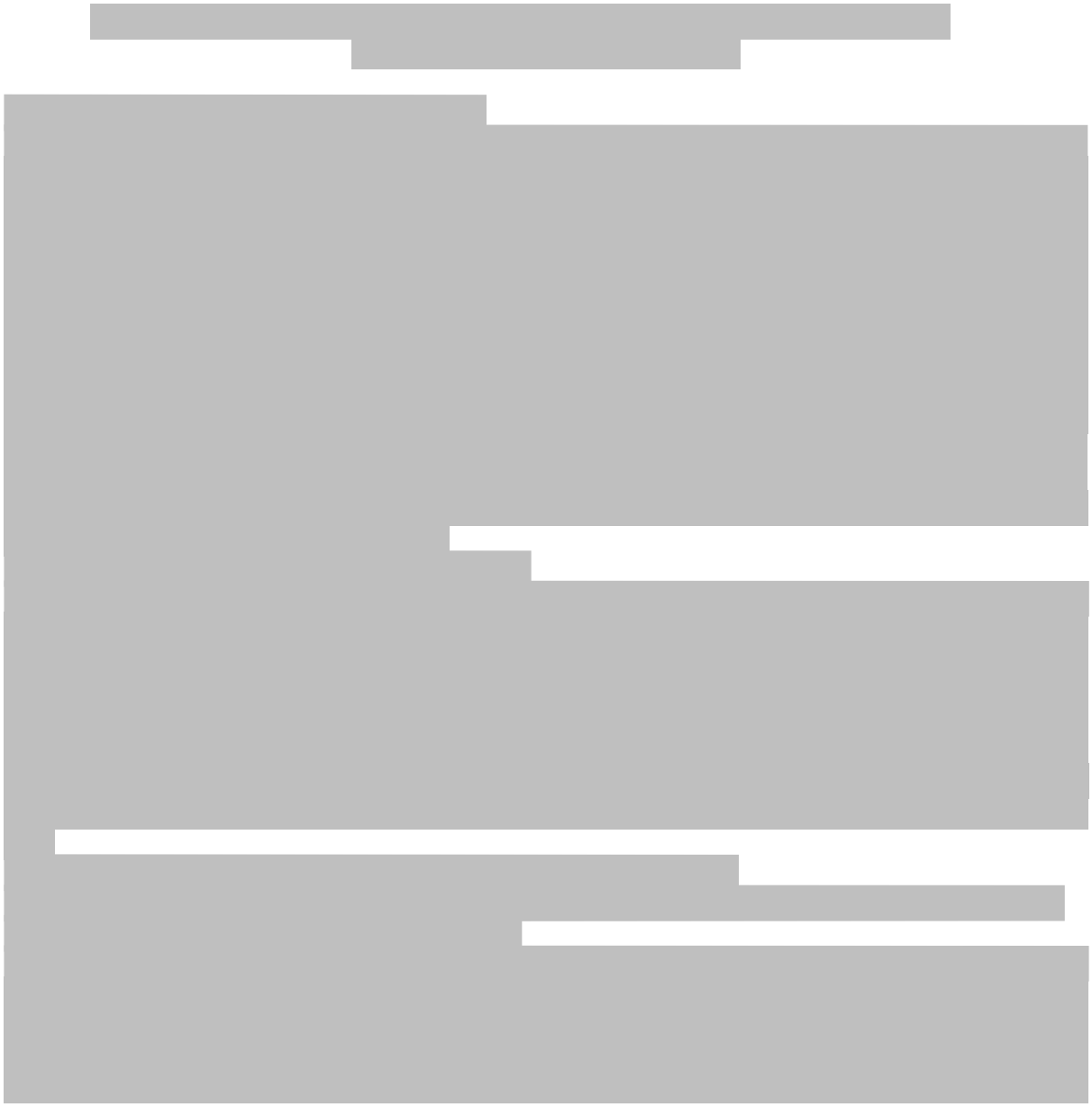
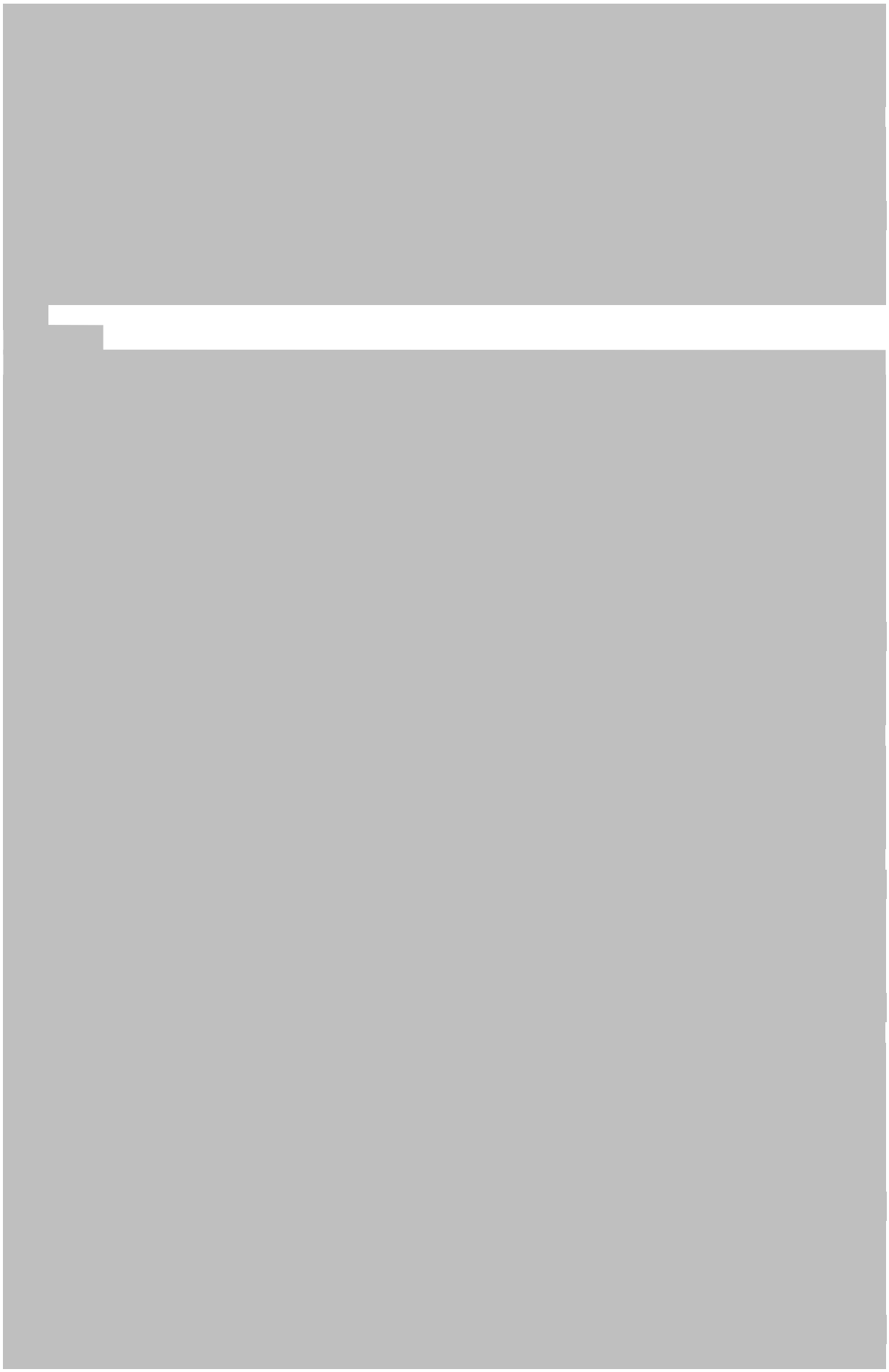
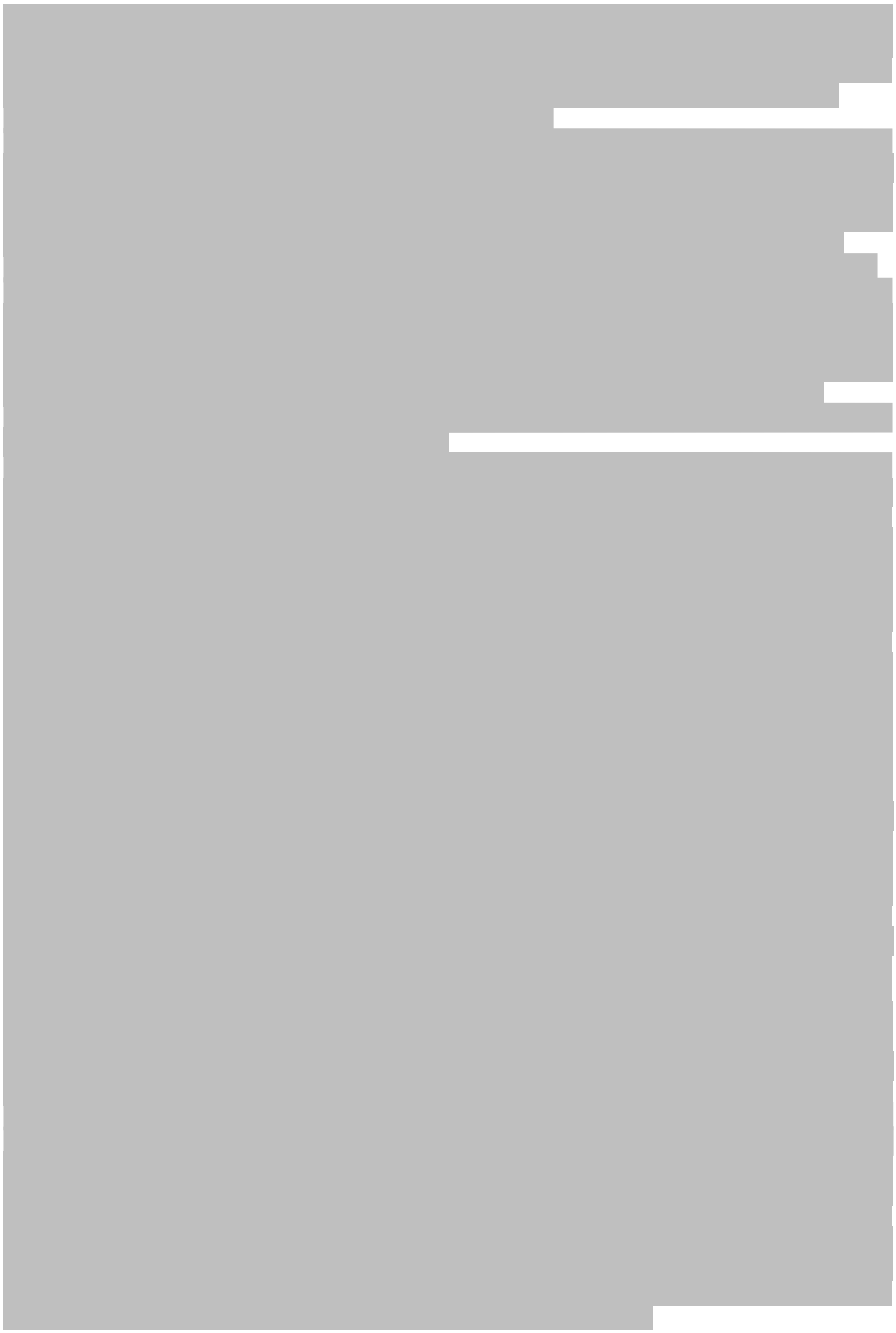
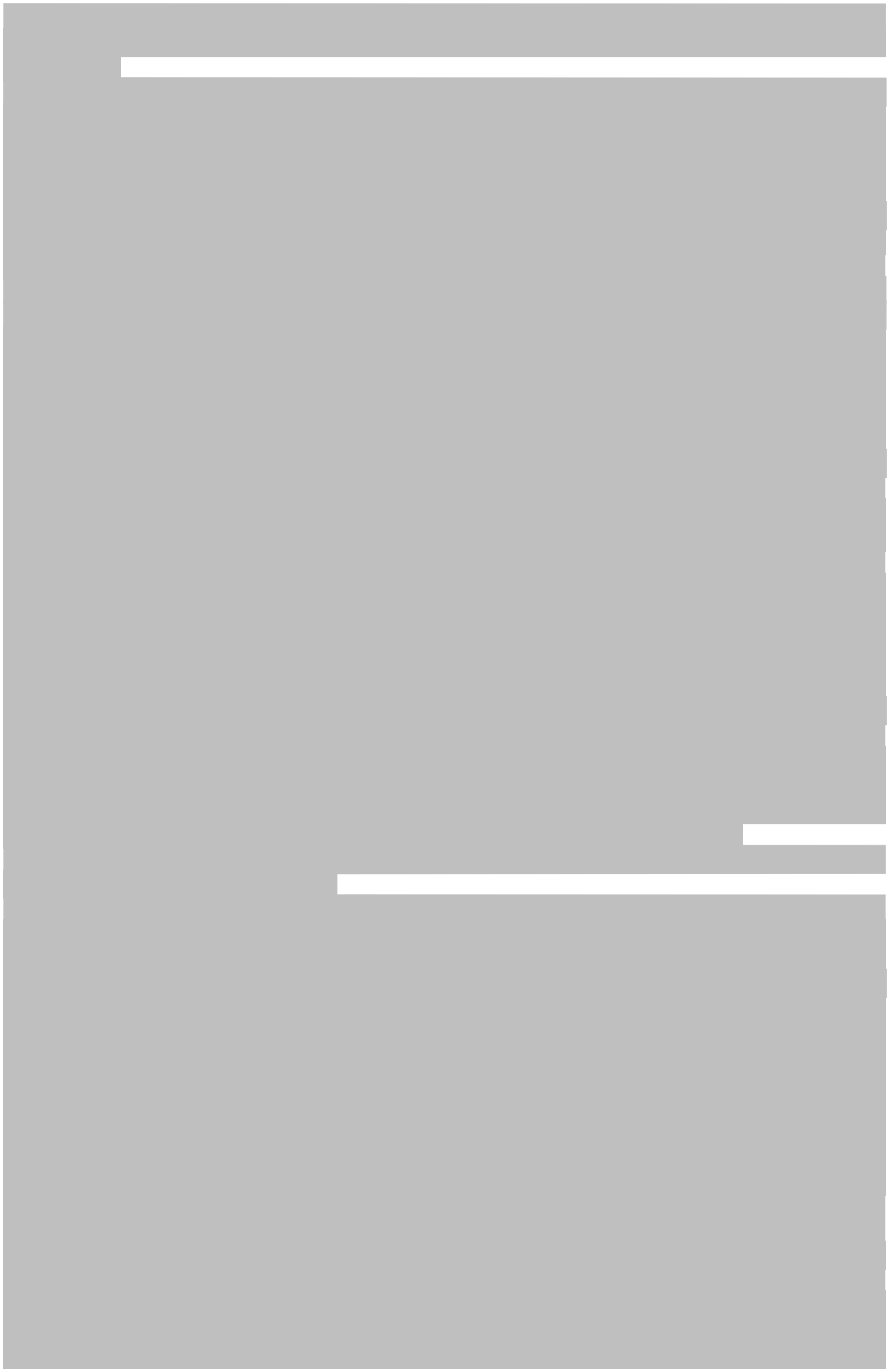


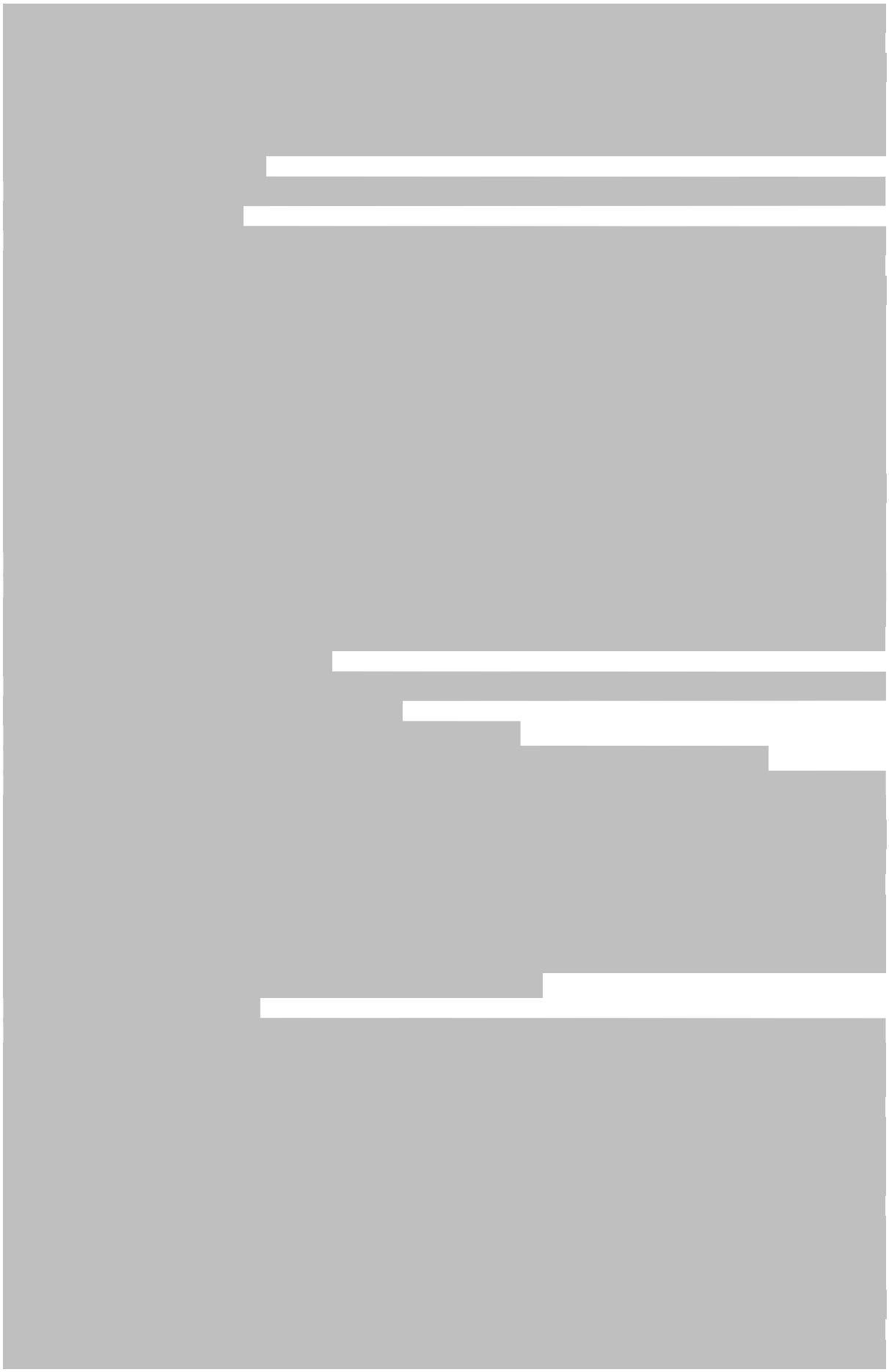
Participant 3

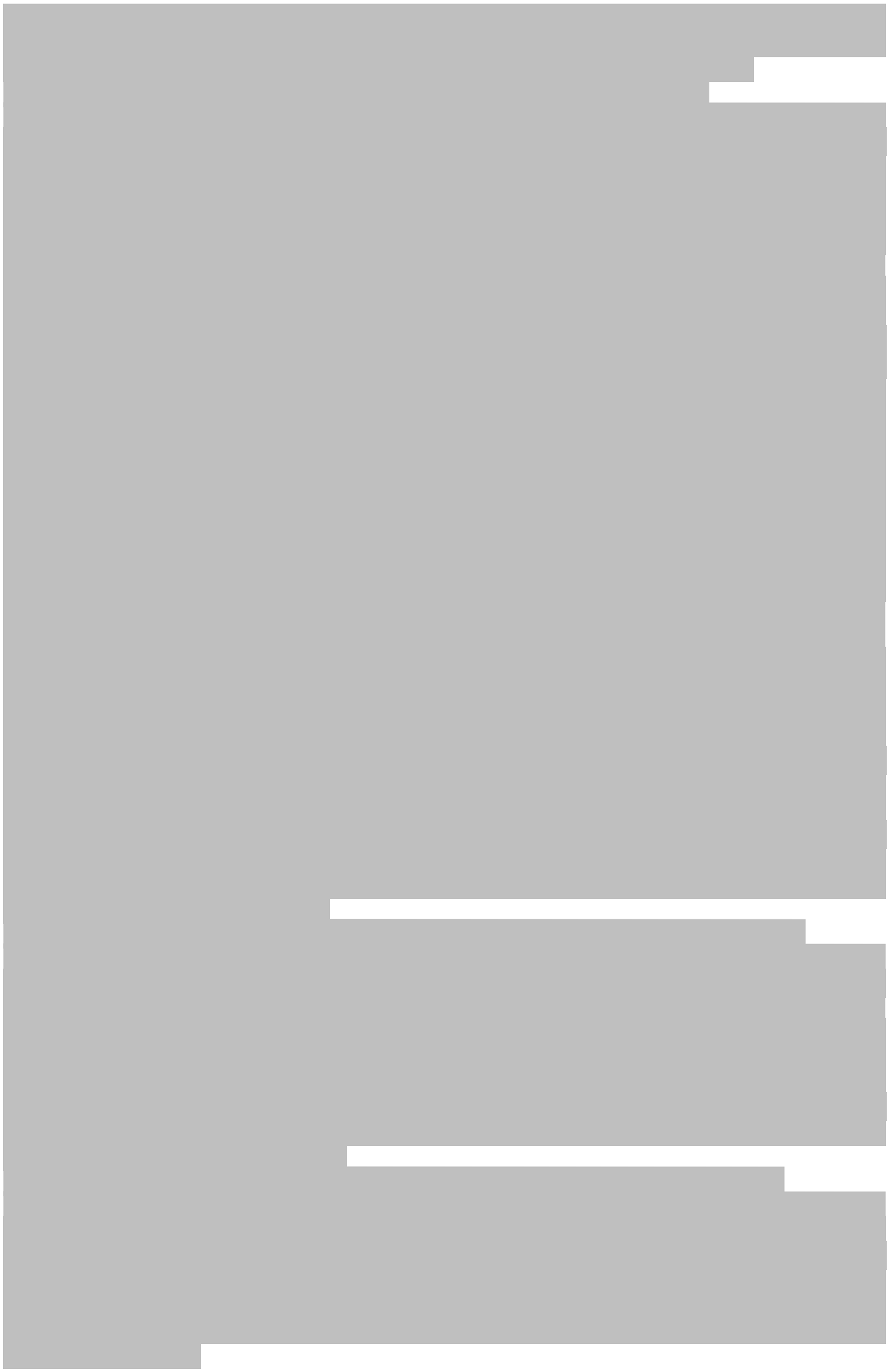




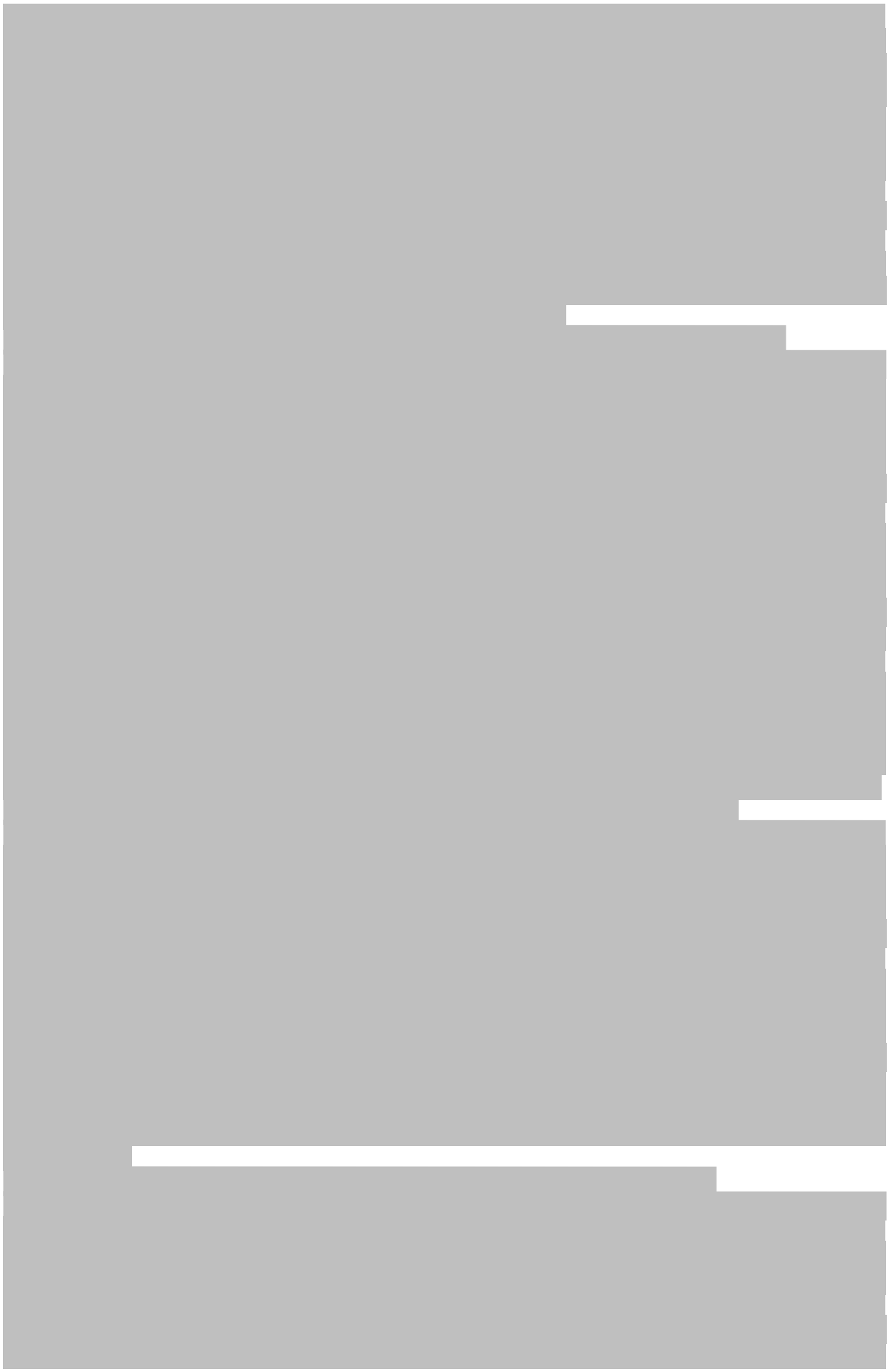


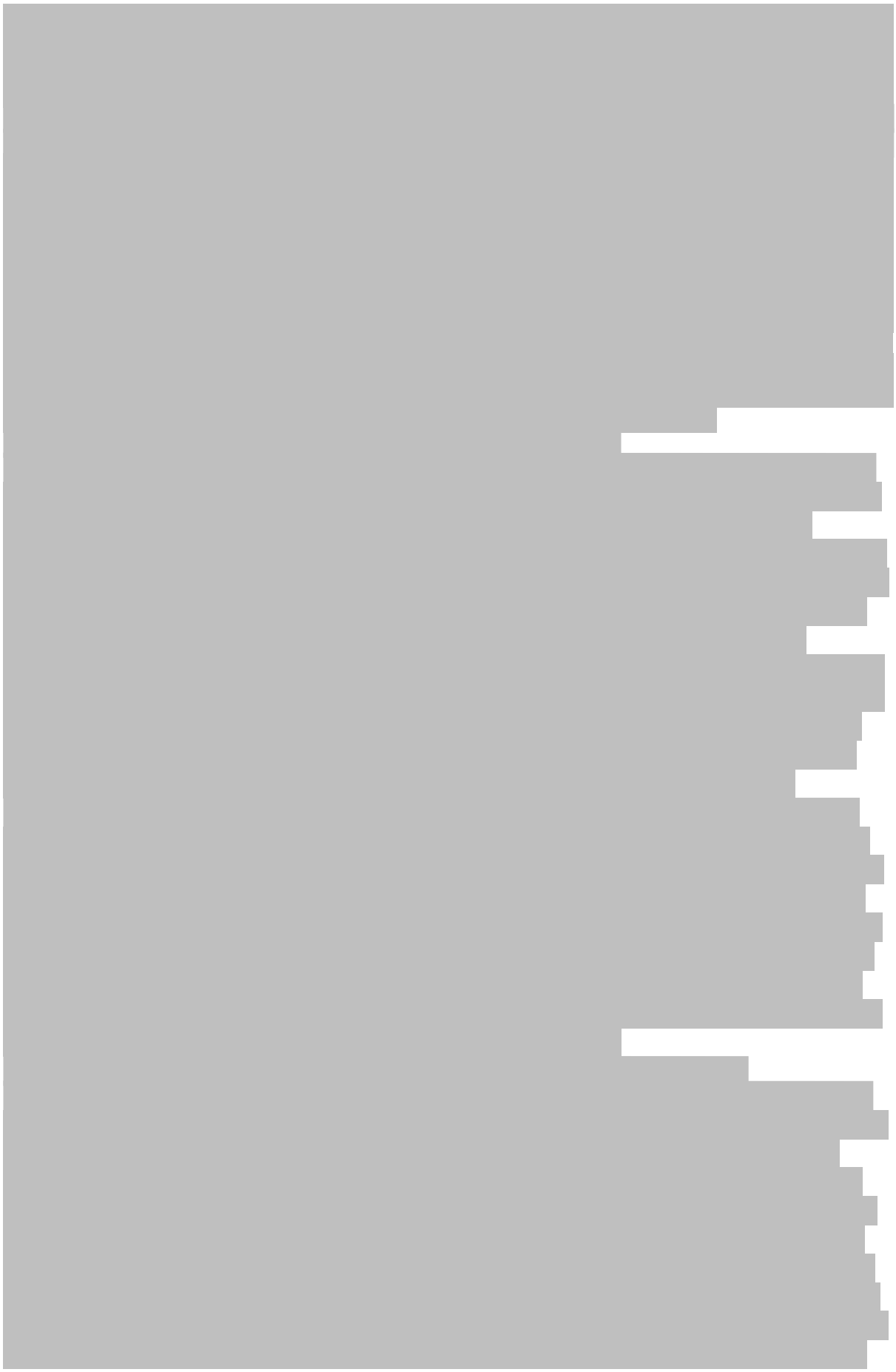


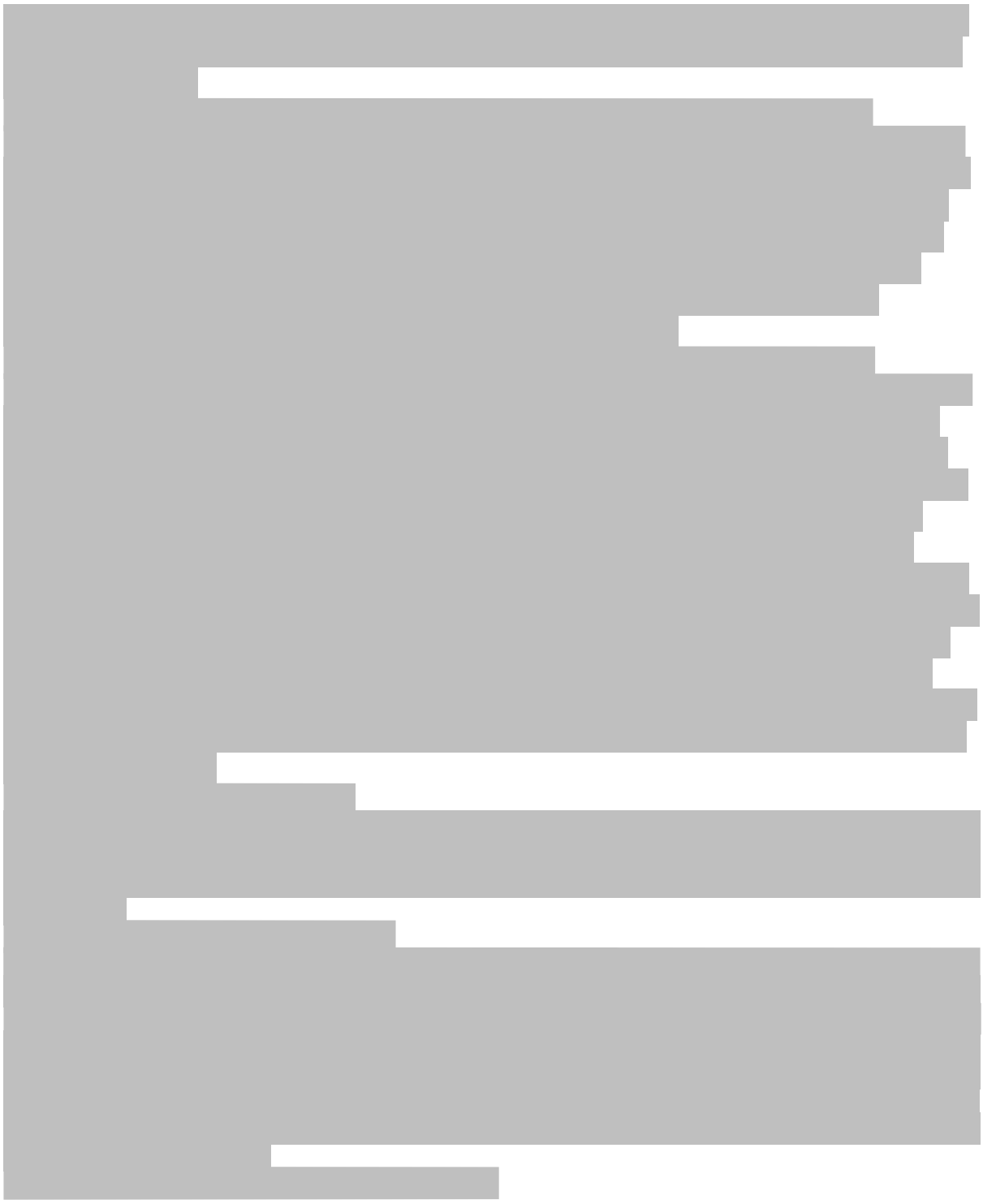




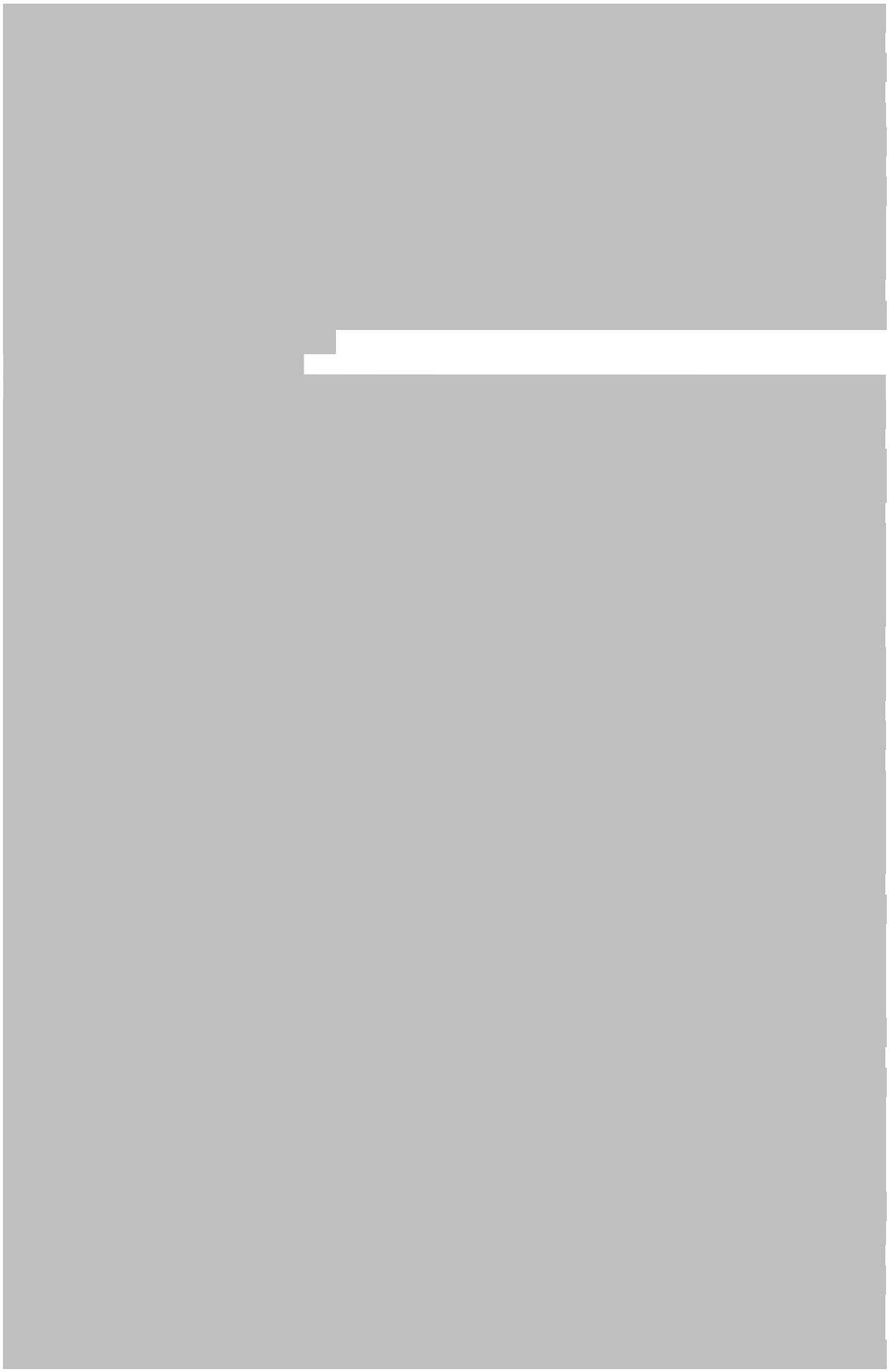
Participant 4

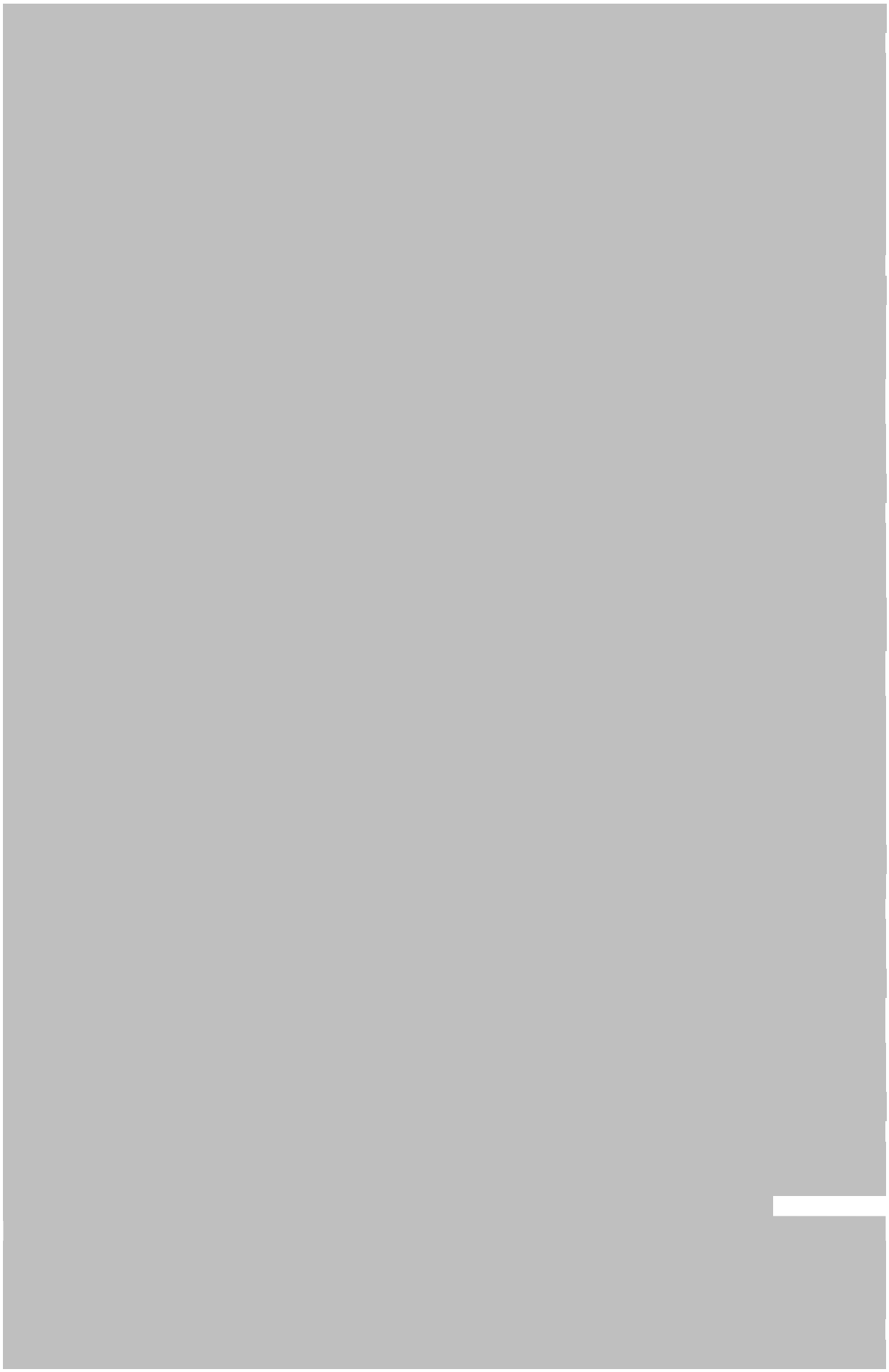


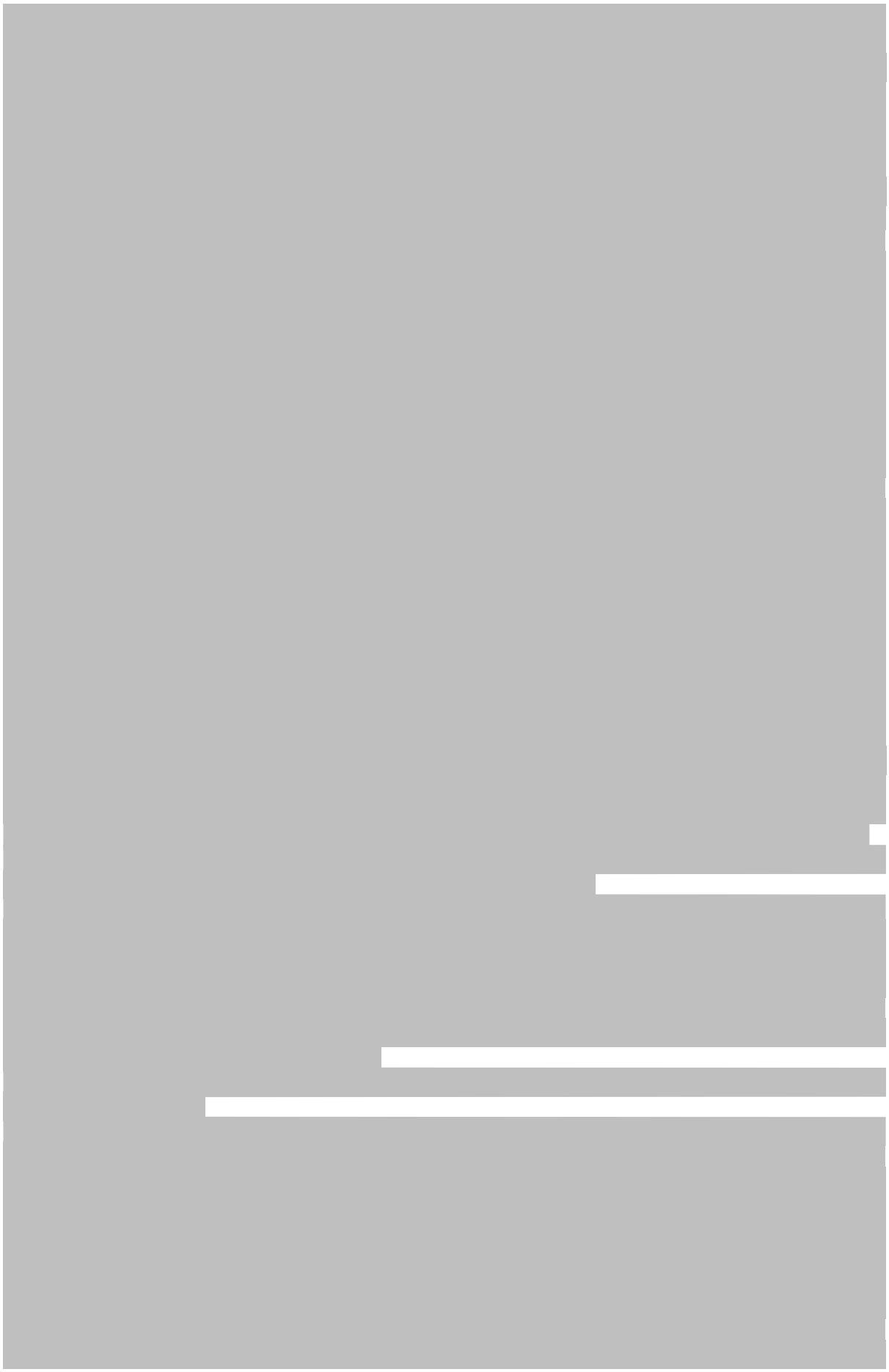


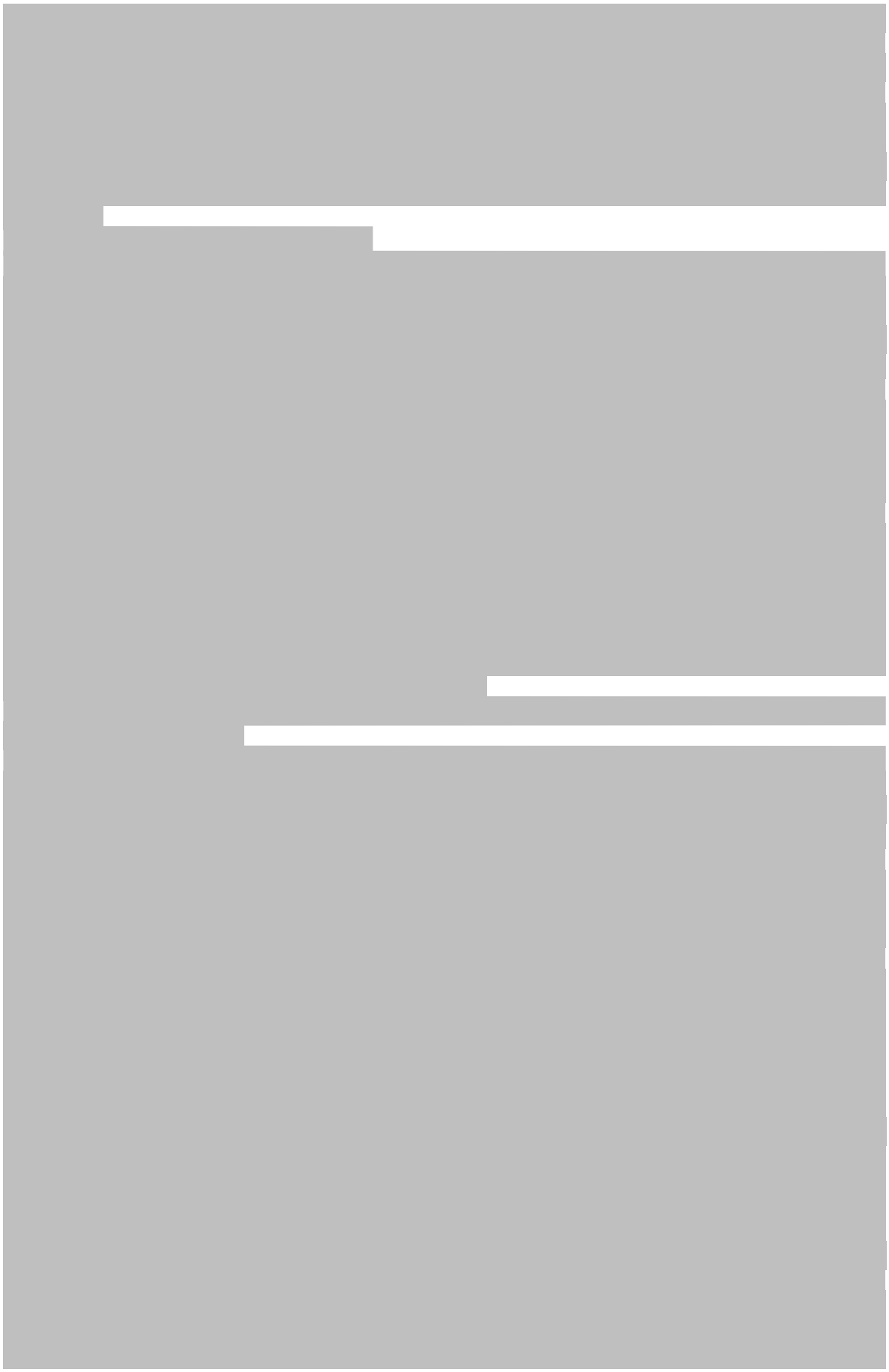


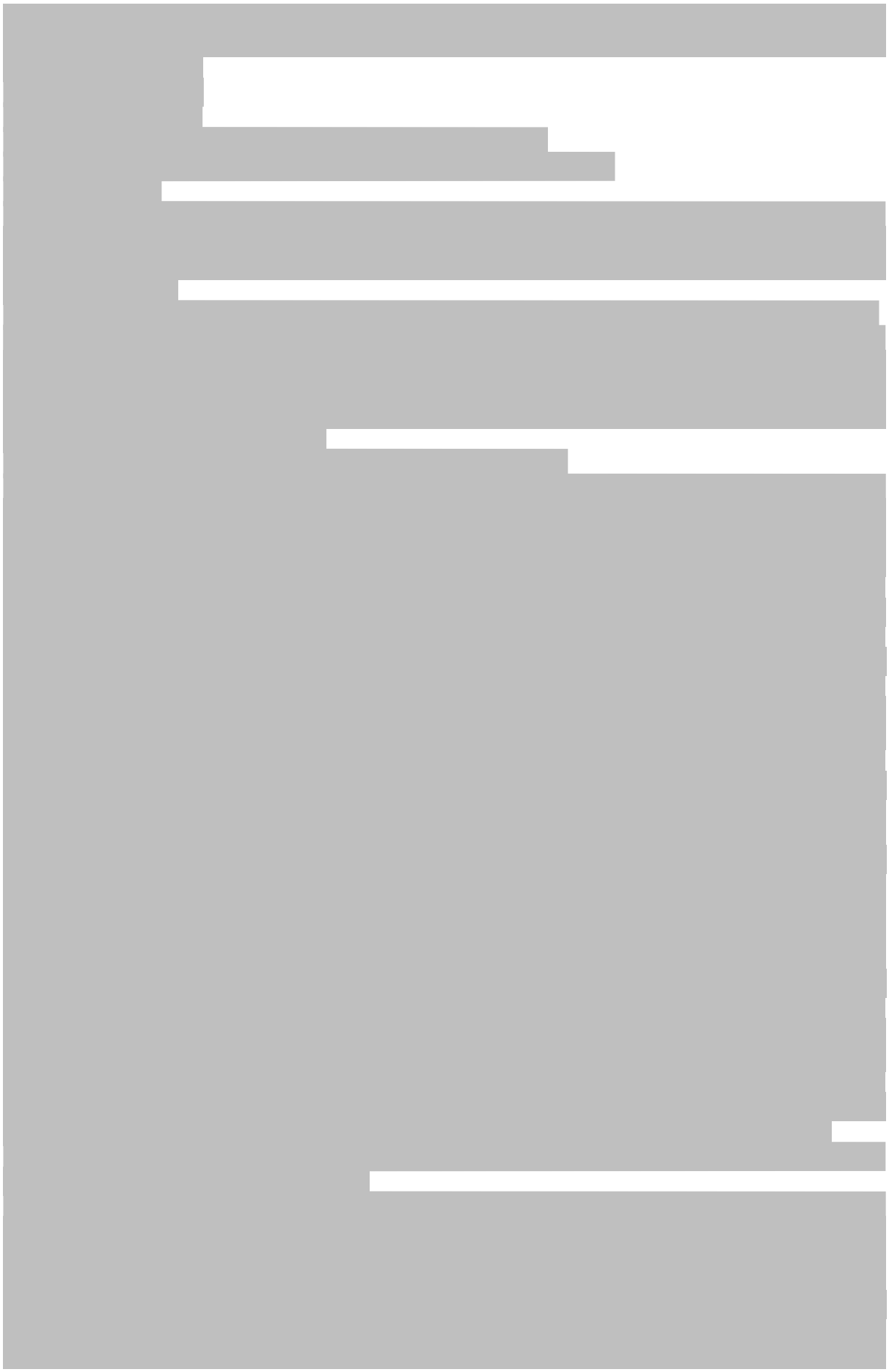
Participant 5

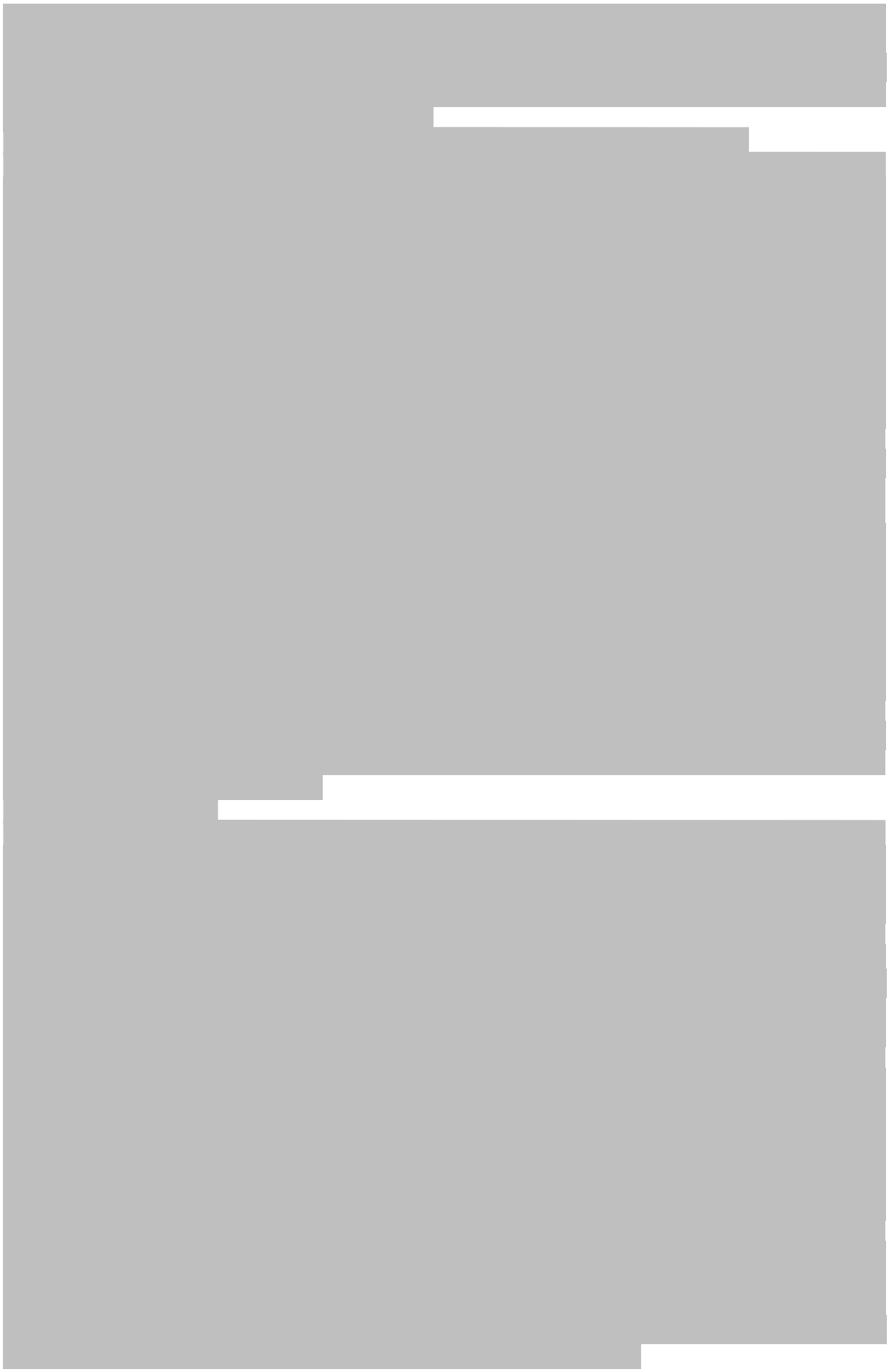


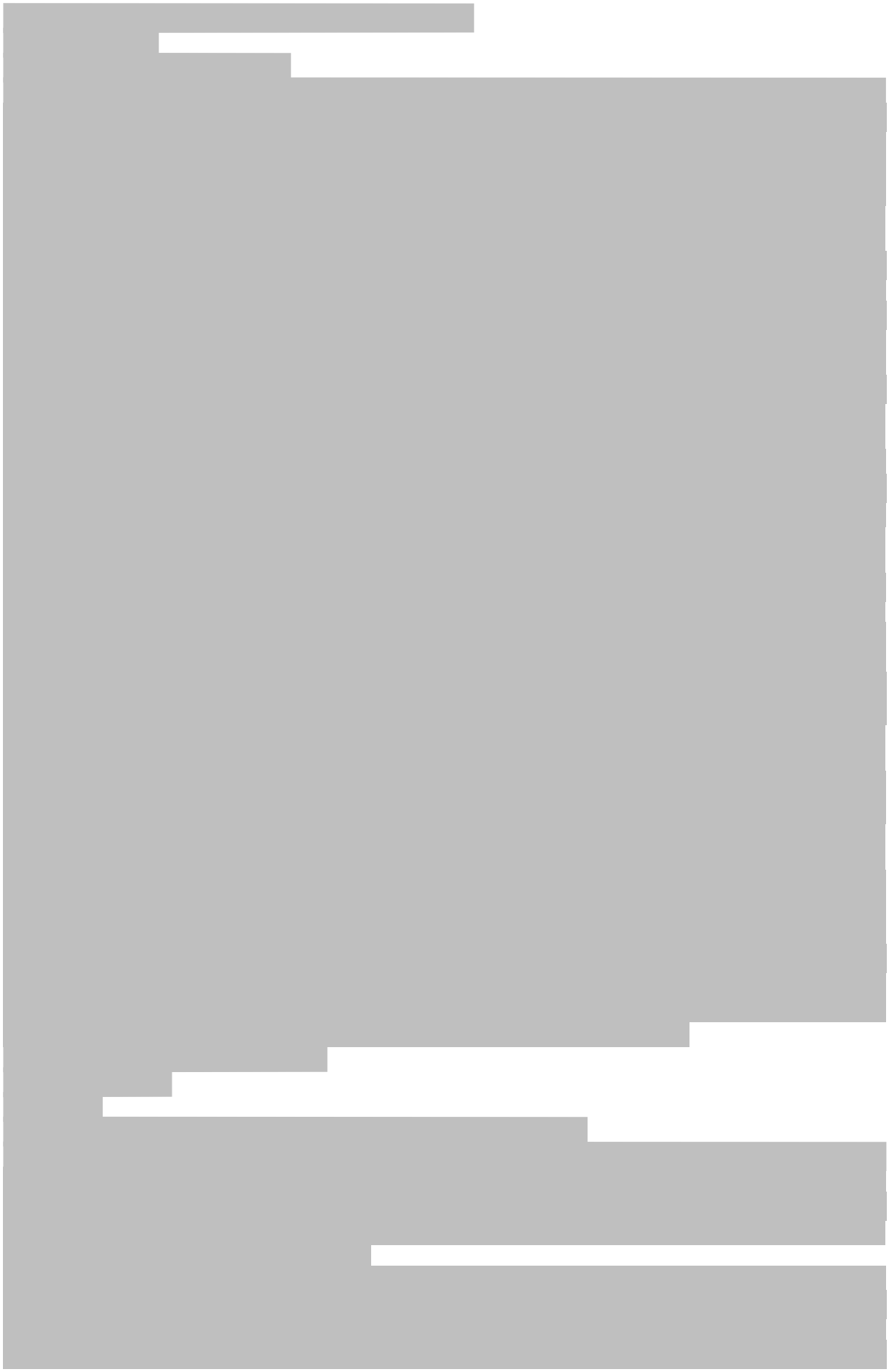








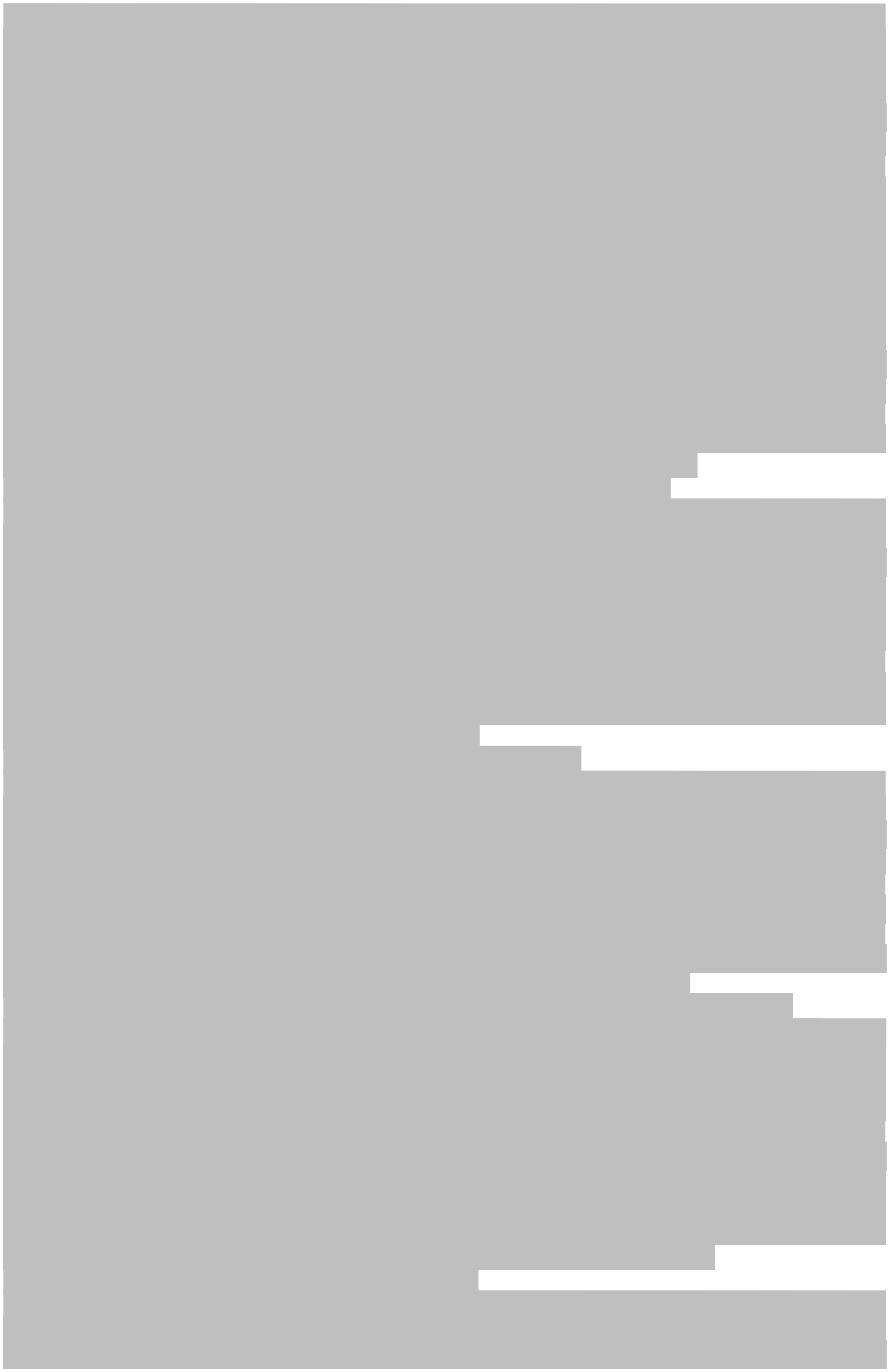


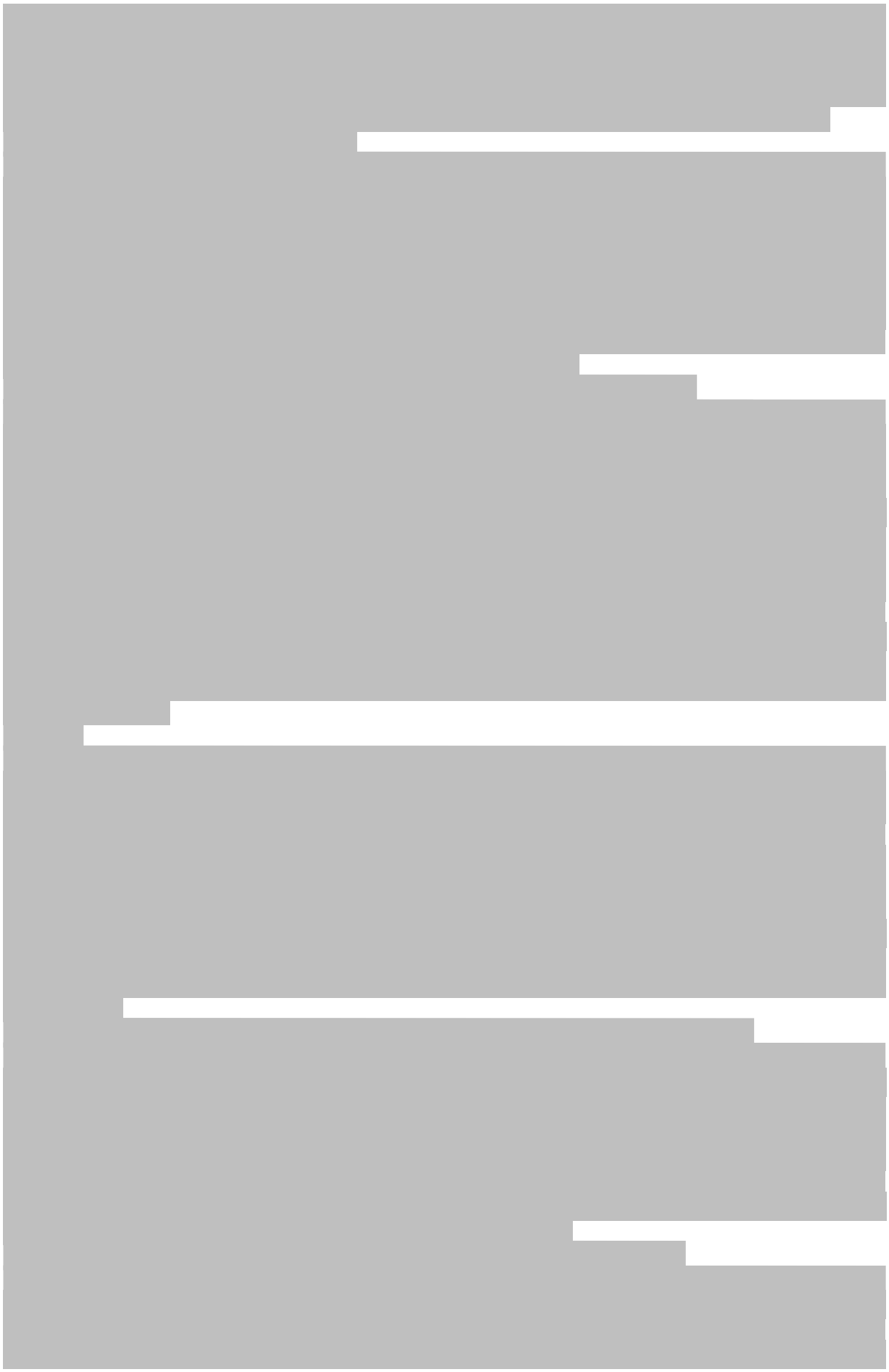


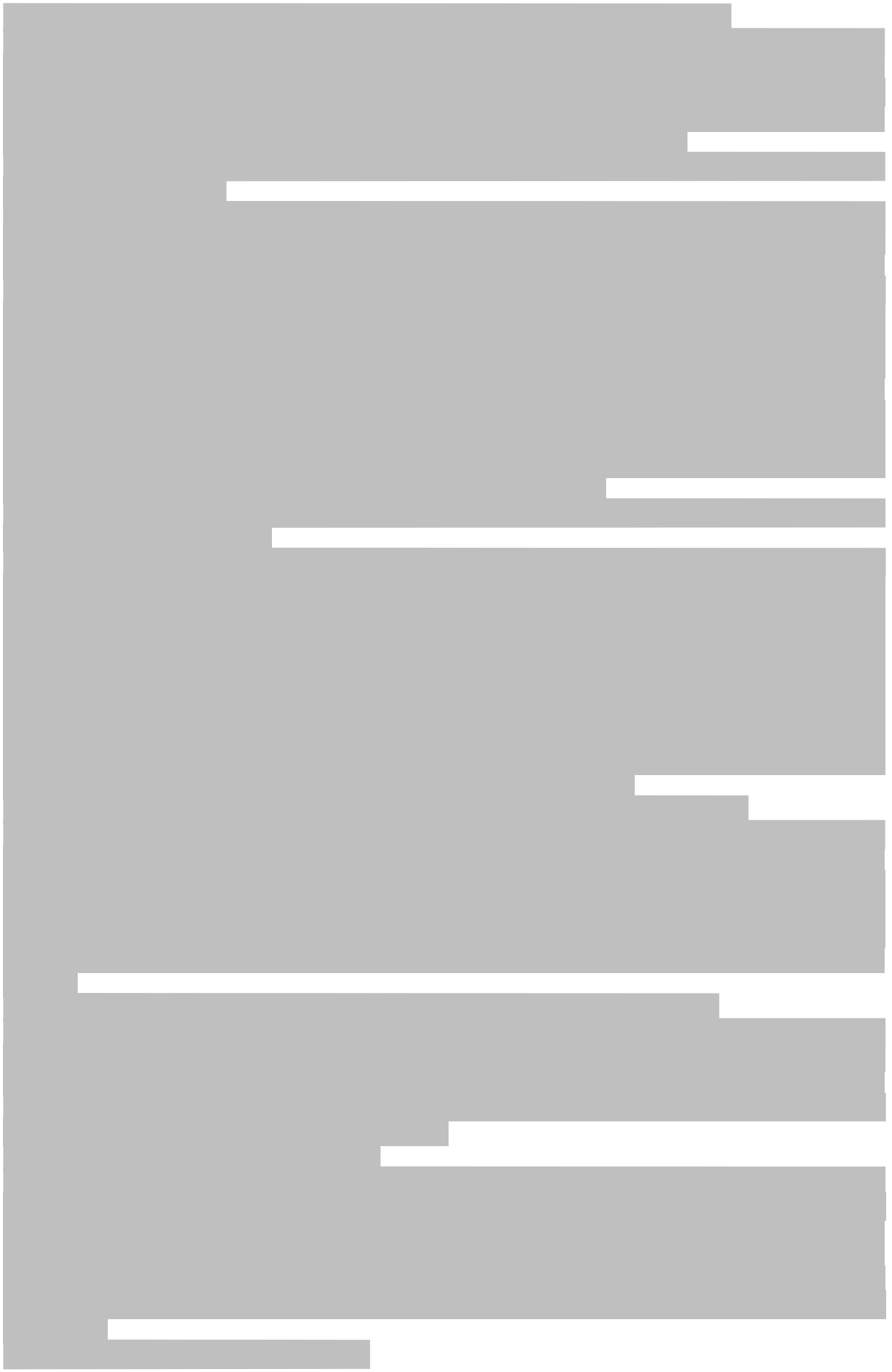
APPENDIX G STRAND TWO S2 LONDON

Participant 6

Participant 7







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Participant 8

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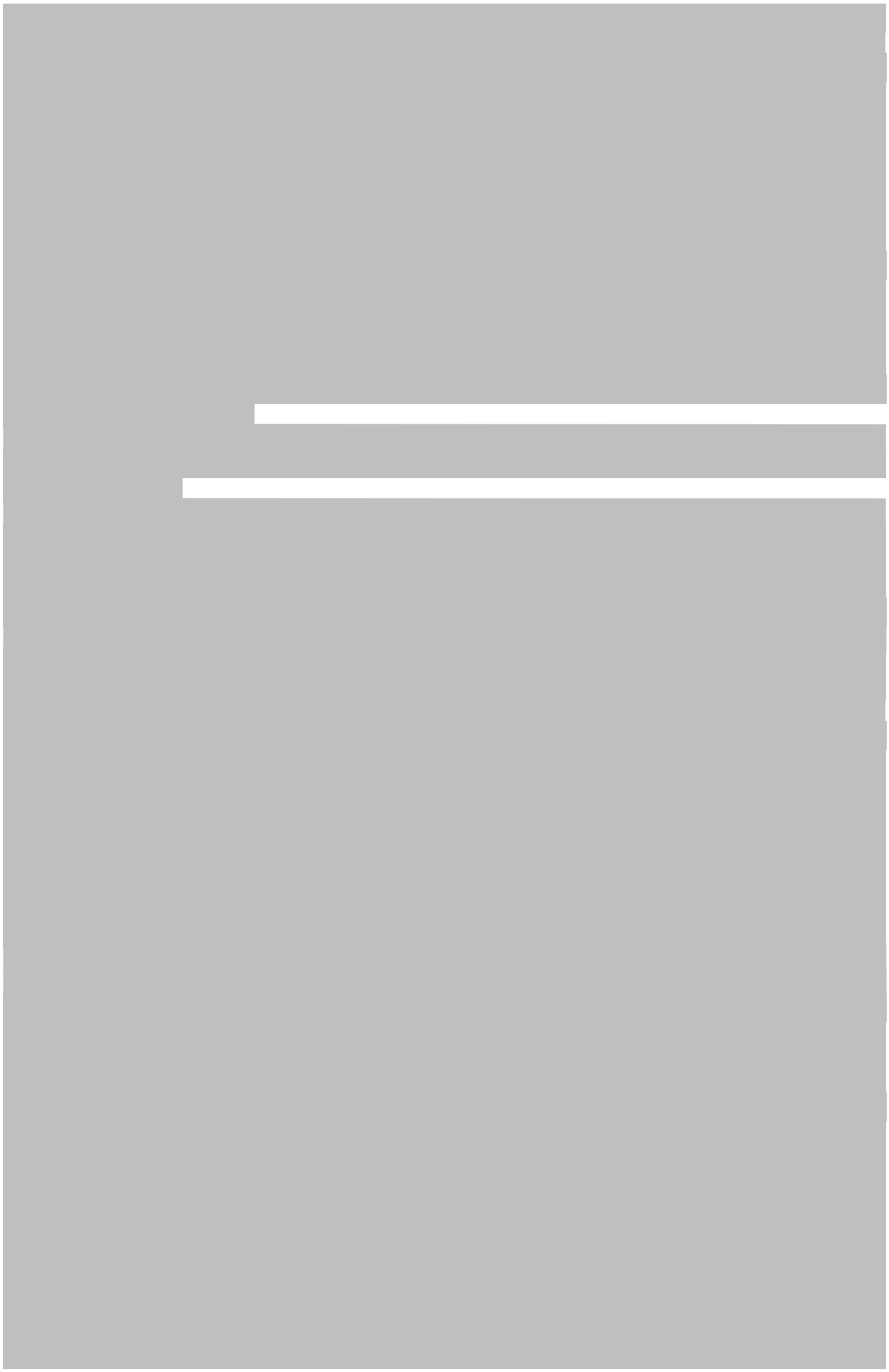
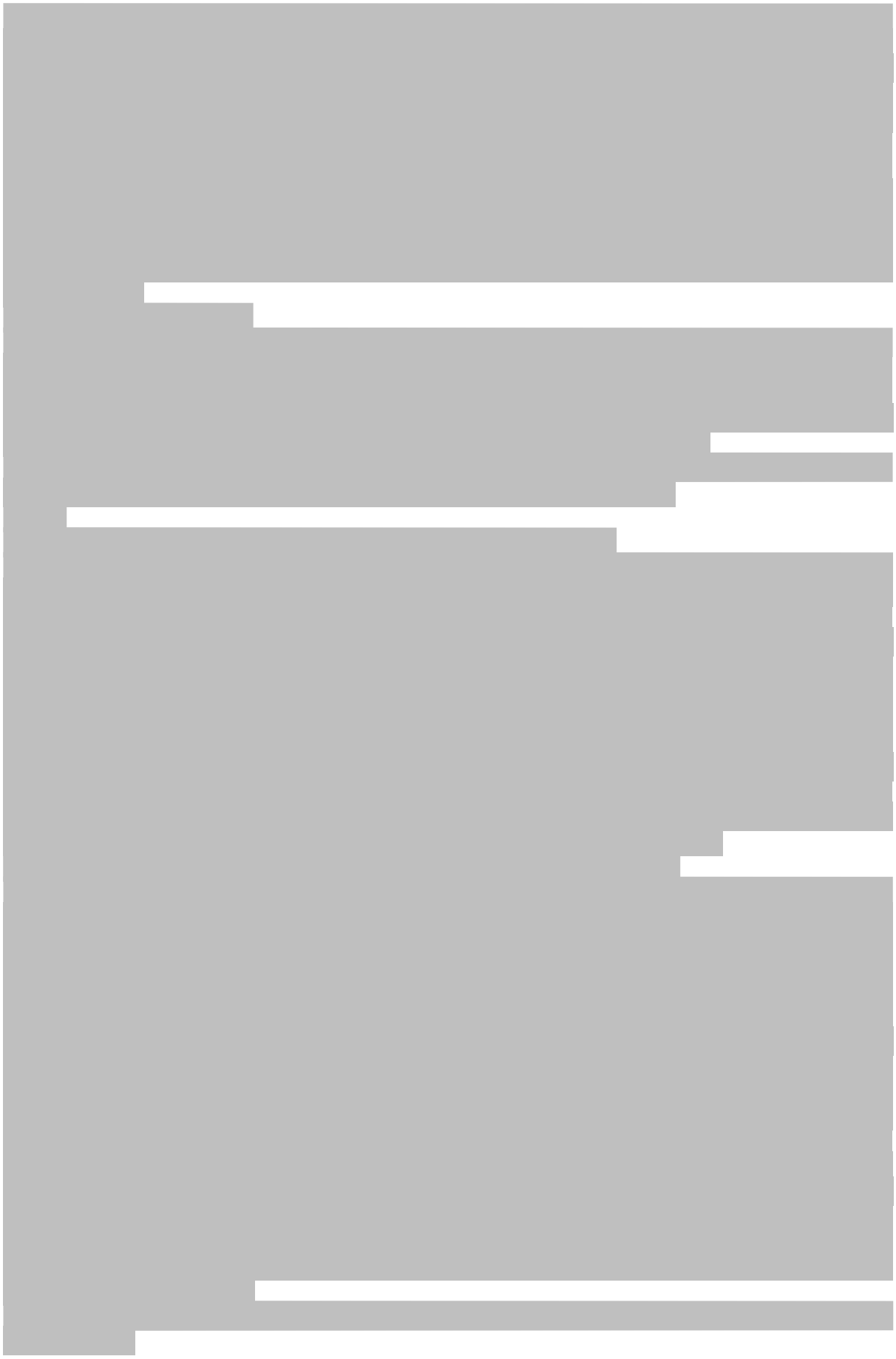


Participant 9



APPENDIX H BIRMINGHAM STAR RATING

1. Birmingham Star Rating (Total)

Star Rating	**Initiatives Birmingham**	**Benefit (Direct + Indirect)**	**Total impact** (multiplier)
***	48	103	309
**	20	38	76
*	13	53	53
Total	**81**	**194**	**438**

2. Birmingham Star Rating (Expanded)

Birmingham Initiatives number	Star rating	Benefit (Direct + Indirect)	Multiplier (initiatives X star rating)
1	3	11	33
2	2	5	10
3	2	3	6
4	2	6	12
5	3	7	21
6	3	9	27
7	2	2	4
8	3	5	15
9	2	4	8
10	3	7	21
11	3	3	9
12	1	3	3
13	2	3	6
14	1	2	2
15	1	5	5
16	1	5	5
17	3	6	18
18	1	7	7
19	1	3	3
20	1	3	3
21	1	4	4
22	3	4	12
23	2	4	8
24	3	7	21
25	1	2	2
26	3	4	12
27	1	4	4
28	3	5	15
29	1	11	11
30	3	3	9
31	3	5	15
32	2	4	8
33	1	1	1
34	3	5	15
35	3	18	54
36	3	4	12
37	1	3	3
38	2	2	4
39	2	5	10
Total	**81**	**194**	**438**

APPENDIX I LONDON STAR RATING

1. London Star Rating (Total)

Star Rating	Initiatives London	Benefit (Direct + Indirect)	Total impact (multiplier)
***	16	86	258
**	19	54	108
*	11	53	53
Total	**46**	**193**	**419**

2. London Star Rating (Expanded)

London Initiatives number	Star rating	Benefit (Direct + Indirect)	Multiplier (initiatives X star rating)
1	3	2	6
2	2	5	10
3	1	2	2
4	1	2	2
5	3	2	6
6	2	3	6
7	2	1	2
8	3	1	3
9	2	3	6
10	3	2	6
11	3	9	27
12	3	4	12
13	3	8	24
14	3	7	21
15	3	4	12
16	3	9	27
17	2	3	6
18	3	5	15
19	3	3	9
20	1	14	14
21	2	3	6
22	2	3	6
23	2	1	2
24	1	5	5
25	3	10	30
26	3	8	24
27	1	3	3
28	1	6	6
29	1	4	4
30	3	6	18
31	1	5	5
32	2	1	2
33	2	5	10

34	3	6	18
35	1	7	7
36	1	4	4
37	1	1	1
38	2	6	12
39	2	2	4
40	2	3	6
41	2	2	4
42	2	2	4
43	2	3	6
44	2	2	4
45	2	4	8
46	2	2	4
Total	**97**	**193**	**419**

APPENDIX J COPENHAGEN STAR RATING

1. Copenhagen Star Rating (Total)

Star Rating	**Initiatives Copenhagen**	**Benefit (Direct + Indirect)**	**Total impact** (multiplier)
***	72	110	330
**	64	117	234
*	3	8	8
Total	**139**	**235**	**572**

2. Copenhagen Star Rating (Expanded)

Copenhagen Initiatives number	**Star rating**	**Benefit (Direct + Indirect)**	**Multiplier (initiatives X star rating)**
1	3	6	18
2	3	3	9
3	3	6	18
4	3	3	9
5	1	3	3
6	1	2	2
7	2	2	4
8	2	1	2
9	2	1	2
10	2	9	18
11	2	4	8
12	3	4	12
13	2	2	4
14	3	6	18
15	2	2	4
16	2	11	22
17	3	6	18
18	2	6	12
19	3	4	12
20	3	8	24
21	2	2	4
22	2	3	6
23	3	4	12
24	2	2	4
25	2	4	8
26	1	3	3
27	2	3	6
28	2	3	6
29	2	2	4
30	3	2	6
31	2	3	6
32	3	2	6
33	3	2	6

34	3	9	27
35	3	5	15
36	3	3	9
37	3	3	9
38	3	3	9
39	3	4	12
40	3	7	21
41	2	3	6
42	3	4	12
43	2	4	8
44	2	5	10
45	2	1	2
46	2	2	4
47	2	3	6
48	2	5	10
49	2	5	10
50	2	3	6
51	2	3	6
52	2	2	4
53	2	4	8
54	2	6	12
55	2	6	12
56	2	5	10
57	3	6	18
58	3	6	18
59	3	4	12
Total	**139**	**235**	**572**

APPENDIX K SINGAPORE STAR RATING

1. Singapore Star Rating (Total)

Star Rating	Initiatives Singapore	Benefit (Direct + Indirect)	Total impact (multiplier)
***	57	48	144
**	34	34	68
*	16	43	43
Total	**107**	**125**	**255**

2. Singapore Star Rating (Expanded)

Singapore Initiatives number	Star rating	Benefit (Direct + Indirect)	Multiplier (initiatives X star rating)
1	3	5	15
2	2	6	12
3	2	6	12
4	3	6	18
5	2	4	8
6	2	2	4
7	3	5	12
8	2	1	2
9	3	1	3
10	1	2	2
11	1	2	2
12	3	4	12
13	2	1	2
14	3	1	3
15	2	2	4
16	2	1	2
17	1	4	4
18	3	3	9
19	3	3	9
20	3	4	12
21	2	2	4
22	3	2	6
23	2	0	2
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25	2	2	4
26	1	1	1
27	3	1	3
28	2	1	2
29	3	1	3
30	2	1	2
31	2	1	2
32	2	1	2
33	3	3	9

34	3	1	3
35	3	2	6
36	2	1	2
37	3	2	6
38	3	1	3
39	3	2	6
40	3	1	3
41	1	3	3
42	1	4	4
43	1	3	3
44	1	3	3
45	1	3	3
46	1	4	4
47	1	3	3
48	1	2	2
49	1	4	4
50	1	3	3
51	1	2	2
52	1	0	0
Total	**107**	**125**	**255**

APPENDIX L PUBLICATION LIST

PUBLISHED

CAVADA, M.; Hunt, D.; Rogers, C. '*Do Smart Cities realise their potential for lower Co_2 emissions*?' Proceedings of the Institution of Civil Engineers Institute of Civil Engineers Engineering Sustainability, Theme issue 2016.
Can be found at: https://www.icevirtuallibrary.com/doi/abs/10.1680/jensu.15.00032

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Can be found at: https://sciforum.net/paper/view/conference/2454

CAVADA, M.; Hunt, D.; Rogers, C. '*The role of infrastructure in Smart Cities*' Conference Proceedings, Conference Proceedings (p72-79). International Symposium for Next Generation Infrastructure, ISNGI London Sept 2017.
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CAVADA, M.; Hunt, D.; Rogers, C. (2017) *SMART - Smart Model Assessment Resilient Tool.*
Can be found at: http://liveablecities.org.uk/outcomes/suite-tools-city-process-engineering

CAVADA, M.; Hunt, D.; Rogers, C.; Poster presentation '*The Smart Cities infrastructure*' at International Symposium for Next Generation Infrastructure,ISNGI London Sept 2017.
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https://www.researchgate.net/publication/323253923_SMART_Smart_Cities_Infrastructure

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Leach, J'; Lee, S.; Boyko, C.; Coulton, C.; Cooper, R; Smith, N.; Joffe, H.; Büchs, M.; Hale, J.; Sadler, J.; Braithwaite, P.; Blunden, L.; Laurentiis, V.; Hunt, D; Bahaj, A.; Barnes, K.; Bouch, C.; Bourikas, B.; **CAVADA, M.;** Chilvers, A.; Clune, S.; Collins, B.; Cosgrave, E.; Dunn, N.; Falkingham, J.; James, P.; Kwami, C.; Locret-Collet, M.; Medda, F.; Ortegon, A.; Pollastri, S.; Popan, C.; Psarikidou, K.; Tyler, N.; Urry, J.; Wu, Y.; Zeeb, V.; Rogers, C.D.F. (2017). '*Dataset of the liveability performance of the city of Birmingham, UK, as measured by its citizen wellbeing, resource security, resource efficiency and carbon emissions' Data Brief.* Open Access funded by Engineering and Physical Sciences Research Council. Pages 691-695. Elsevier Inc.
Can be found at: https://www.ncbi.nlm.nih.gov/pubmed/29124092

Leach, J., Bartle, I., Hale, J., Bouch, C.; Boyko, C.; Lee, S.; De Laurentiis, V.; **CAVADA, M.;** Locret, M., Hunt, D.; Sadler, J., & Rogers, C, (2015). '*Critical infrastructures and sharing: implications for UK*

centralised infrastructure systems'. Proceedings International Symposium Next Generation Infrastructure. p80-88.
Found at: http://isngi.org/wp-content/uploads/2017/10/ISNGI-Conference-Proceedings-v2.pdf

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Can be found at: http://liveablecities.org.uk/outcomes/little-book-series

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SUBMITTED

Gerey, O. (Smart Dubai); Carriero, D.; Bueti C, **CAVADA, M. ROGERS C.D.F**.[…] Ubeta, R. (2018) United Nations Economic Commission For Europe (UNECE) '*Guidelines on Strategies for Circular Cities*'. United 4 Smart Sustainable Cities U4SSC and International Telecommunications Union (ITU),(forthcoming).
Information can be found here: https://www.itu.int/en/ITU-T/ssc/united/Pages/default.aspx

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